DECEMBER

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor-in-chief

DIRECTORY OF LOW-PRICED TRANSISTORS

OVER 450 TYPES LISTED

Helpful roundup of transistors in the $5-and-under class shows voltage, current, cutoff, case and base information. Useful for replacement or design.

BUILD:

ZENER VOLTAGE CALIBRATOR

Simple, accurate device gives four check points between 0 and 20 volts.

5-MICROAMP RELAY

A transistor or photocell plus an old meter make a sensitive relay

ELECTRONIC SHOOTING GALLERY

Christmas fun for the youngsters. Transistors make it safe.

REVERBERATION AND YOUR HI-FI AUDIO

Is reverb a new aid to high fidelity or just another gimmick? The pros and cons, plus some commercial circuits.

COMPLETE R-E 1961 INDEX

Individual Benches Speed Servicing

See page 4

50c

Radio-Electronics

DECEMBER 1961
VOL. XXXII No. 12

Formerly RADIO CRAFT — Incorporating SHORT WAVE CRAFT — TELEVISION NEWS — RADIO & TELEVISION*

editorial

stereo-audio-high fidelity

what's new

electronics

radio

industrial electronics

television

test instruments

the departments

—on the cover—

(More on page 38)

Front end of the line in the New York City shop of Ernest Mumola. He finds that the idea improves work, saves time.

Color original by Irving Kaufman

Gernsback Publications, Inc.
EXECUTIVE, EDITORIAL, ADVERTISING OFFICES
154 W. 14 St., New York 11, N.Y.
Telephone AL 5-7755

CHAIRMAN OF THE BOARD
Hugo Gernsback

PRESIDENT
M. Harvey Gernsback

SECRETARY
G. Aliquo

Radio-Electronics is indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

GET YOUR ELECTRONICS-TV-RADIO HOME TRAINING FROM N.T.S. RESIDENT SCHOOL

BREAK THROUGH TO HIGHER PAY, GREATER JOB SECURITY

START NOW! Break through the Earning Barrier that stops "half-trained" men. **N.T.S.** "All-Phase" Training prepares you . . . at home in spare time . . . for a high-paying **CAREER** as a **MASTER TECHNICIAN** in Electronics — TV — Radio. One Master Course at One Low Tuition trains you for unlimited opportunities in All Phases: Servicing, Communications, Preparation for F.C.C. License, Broadcasting, Manufacturing, Automation, Radar and Micro-Waves, Missile and Rocket Projects.

A MORE REWARDING JOB . . . a secure future . . . a richer, fuller life can be yours! As an **N.T.S. MASTER TECHNICIAN** you can go straight to the top in industry . . . or open your own profitable business.

Over 1 City Block of Modern School Facilities, Laboratories and Shops Housing Over 1,000 Students.

50,000 Graduates — all over the World — since 1905

BETTER ...MORE COMPLETE ...LOWER COST ...WITH NATIONAL SCHOOLS' SHOP-METHOD HOME TRAINING!

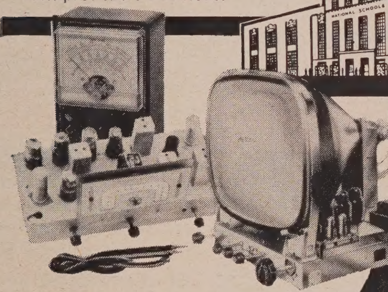
BETTER
. . . Training that is proved and tested in **N.T.S.** Resident School shops and laboratories, by a School that is the **OLDEST** and **LARGEST** of its kind in the world.

MORE COMPLETE
. . . You learn **ALL PHASES OF** Television — Radio — Electronics.

LOWER COST
. . . Other schools make several courses out of the material in our **ONE MASTER COURSE** . . . and you pay more for less training than you get in our course at **ONE LOW TUITION!**

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905

THE SCHOOL BEHIND YOUR HOME-STUDY TRAINING



In these modern School Headquarters your Home Training is: Classroom-Developed, Lab-Studio Planned, Shop-Tested, Industry-Approved, Home Study-Designed.

19 BIG KITS YOURS TO KEEP

- Friendly Instruction and Guidance
- Graduate Advisory Service
- Unlimited Consultation
- Diploma Recognized by Industry
- **EVERYTHING YOU NEED FOR SUCCESS**

N.T.S. IS NOT JUST A MAILING ADDRESS ON A COUPON

N.T.S. is a real school . . . a world famous training center since 1905. Thousands of men from all over the world come to train in our shops, labs, studios and classrooms. You learn quickly and easily the N.T.S. Shop-Tested way. You get lessons, manuals, job projects, personal consultation from instructors as you progress. You build a Short-Wave, Long-Wave Superhet Receiver plus a large screen TV set from the ground up with parts we send you at no additional cost. You also get a Professional Multitester for your practical job projects. The Multitester will become one of your most valuable instruments in spare time work while training, and afterwards, too. Many students pay for their entire tuition with spare time work. You can, too . . . we show you how.

SEND FOR INFORMATION NOW . . . TODAY! IT COSTS YOU NOTHING TO INVESTIGATE

After you graduate you can open your own TV-Radio repair business or go into high paying jobs like these: Communications Technicians, Hi-Fi, Stereo and Sound Recording Specialists, TV-Radio Broadcasting Technician, Technician in Computers & Missiles, Electronics Field Technician, Specialist in Micro-Waves and Servomechanisms, Expert Trouble Shooter, All-Phase Master Technician, TV-Radio Sales, Service and Repair.

RESIDENT TRAINING AT LOS ANGELES
If you wish to take your Electronics-TV-Radio training in our famous Resident School in Los Angeles — the oldest and largest school of its kind in the world — write for special Resident School catalog and information, or check special box in coupon.

ACCREDITED MEMBER

ACCREDITED SCHOOL · NATIONAL HOME STUDY COUNCIL · NHSC

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905
4000 SO. FIGUEROA ST., LOS ANGELES 37, CALIF., U. S. A.

MAIL COUPON NOW FOR FREE BOOK & ACTUAL LESSON

No obligation.

No salesman will call.

NATIONAL TECHNICAL SCHOOLS
WORLD-WIDE TRAINING SINCE 1905

Mail Now To
National Technical Schools, Dept. RG121
4000 S. Figueroa St., Los Angeles 37, Calif.
Please rush FREE Electronics - TV-Radio "Opportunity" Book and Actual Lesson.

Name__________ Age____
Address__________
City______ Zone___ State______

☐ Check here if interested ONLY in Resident Training at Los Angeles.

VETERANS: Give date of discharge__________

RADIO-ELECTRONICS published monthly at Mt. Morris, Ill., by Gernsback Publications Inc. Second-class postage paid at Mt. Morris, Ill. SUBSCRIPTION RATES: US and possessions, Canada; $5 for 1, $9 for 2, $12 for 3 years. Pan-American countries: $6 for 1, $11 for 2, $15 for 3 years. Other countries: $6.50 for 1, $12 for 2, $16.50 for 3 years.

News Briefs

Practical Ion Engine May Give Us Edge in Space

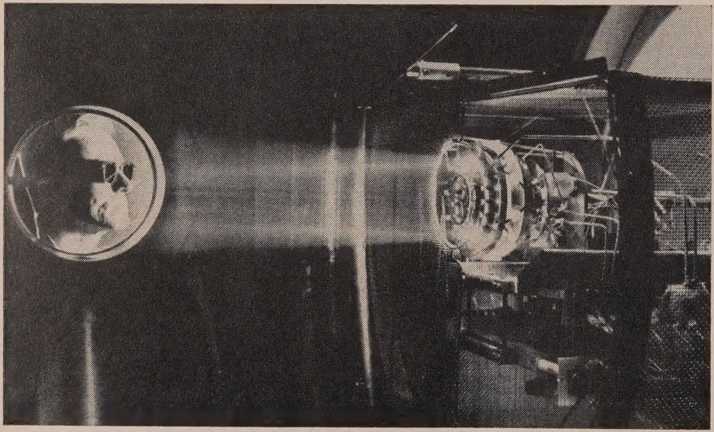
A working ion engine, demonstrating principles that might eventually send a spacecraft to Mars at 2,000,000 miles a day, was shown to science and technical writers at the Hughes Aircraft Co. research laboratory at Malibu, Calif. Newsmen were shown the engine actually operating in a vacuum chamber which duplicates as closely as possible the conditions which the engine will encounter in space.

Hughes scientists said that an actual test of the engine in space is planned for 1962. Asked how soon we might expect a space ship to make the round trip to Mars, they suggested 1975 or 1980 as a reasonable estimate.

The principles of ion propulsion were outlined in detail by Prof. Hermann Oberth in a two-article series "Electric Space Ships" in RADIO-ELECTRONICS in December 1950 and January 1951. Briefly, a propellant, usually cesium, is stored in a reservoir from which cesium vapor is diffused through a hot tungsten element which ionizes the cesium by contact ionization. There then follows a system of electrodes to which voltage is applied to accelerate the ions to a very high exhaust velocity.

Finally, the high-velocity ion beam passes through a neutralizer region in which electrons are injected into the beam to neutralize the positive charge of the cesium ions. It is necessary to emit electrons at exactly the same rate as ions. If only the positive ions were ejected, the spacecraft would become highly charged negatively, until it pulled the ions back to the ship (or the ship back to the ions). It is also necessary, the Hughes scientists explained, that the electrons and ions be intimately mixed very close to the vehicle to neutralize the charge everywhere in the beam. Otherwise, the thrust can be reduced greatly by beam divergence and return of unneutralized portions of the beam to the ship.

The great advantage of the ion engine is economy—it will drive a ship 20 or 30 times as far as will a chemical rocket engine with the same amount of fuel. Its disadvantage is that it does not have enough thrust to get a ship out of the earth's gravity, and thus must have a rocket booster or start from a space platform or satellite.



Ion engine being tested under simulated space conditions.

Computer Talks Back In New Inquiry Device

A device to be used for making train and flight reservations, and for many similar jobs, which gives replies to requests in voice was demonstrated by Remington Rand Univac at the opening of the Univac engineering and research center at Whitpain, Pa.

The unit is expected to simplify and accelerate updating and reporting of changes in inventory, production, distribution and sale. It will also have applications in hotels, auto rental agencies and department stores.

Unicall is attached to an ordinary telephone circuit by setting up levers at the correct points on its face. In the unit demonstrated, intended for airline reservations, the levers could select airline names, types of request (first available space, cancel, etc.), dates and other pertinent data. The user simply pulls the lever down opposite the pertinent abbreviation, number or letter. A button was pressed to transmit the message on tones of the type the telephone company uses in its long-distance dialing systems. The answer "first available space Flight 471, Oct. 14" came back immediately by voice over the telephone. The answering component was Univac's computer at St. Paul, Minn. It had checked available space, then answered with the help of spoken phrases selected from a number stored on its magnetic memory drums.

Because of the machine's speed and the ability of the central computer to handle large numbers of inquiries almost simultaneously, it is to be a low-cost device. Monthly rental of a single unit is expected to cost about $30, with something less than $10 of telephone company equipment, plus regular line charges.

Spacecraft Not Germcarriers

The vacuum of space is likely to kill bacteria and fungi, if pressures are low enough and the exposure is prolonged, declares Charles G. Walance, manager of the Hughes Aircraft Co. components and materials laboratory. Experiments made at the laboratory show that micro-organisms can survive relatively high vacuums, giving rise to the opinion that they can live in space. But if more realistic space conditions were approximated, they were unable to survive. All micro-organisms were killed in a 30-day "flight" at a pressure equal to that about 300 miles above the earth.

Even a shorter flight in real space might be fatal to germs, researchers

Advertising Representatives: **Los Angeles:** Harker-Husted-Coughlin, 408½ South Alvarado St., Tel. DUnkirk 7-2328. **San Francisco:** Harker-Husted-Coughlin, 444 Market St., Tel. GArfield 1-0151. **Atlanta:** J. Sidney Crane & Associates, 22 Eighth St. N.E., Tel. TRinity 2-6720. **United Kingdom:** Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London, W. 1, England

Foreign Agents: **Great Britain:** Atlas Publishing and Distributing Co., Ltd., 18 Bride Lane, London E.C. 4.

Subscription Service Address form 3579 and correspondence to Radio-Electronics, Subscriber Service, 154 West 14th St., New York 11, N.Y. When requesting a change of address, please furnish an address label from a recent issue. Allow one month for change of address.

believe. In real space, they would be subject to ultraviolet and other radiation as well as vacuum. At any rate, sterilization of moon rockets is unnecessary. Any surviving micro-organisms landing on the moon would be killed by the high vacuum there.

Broadcasting 55 Years Old

Dec. 24, 1961, marks the 55th anniversary of the first radio broadcast. Speech and music were transmitted by high-frequency alternator from Brant Rock, off the coast of Massachusetts, to an audience composed largely of ship operators. Sponsor of the broadcast was wireless pioneer Reginald Fessenden and his National Electric Signaling Co. Fessenden reported on the 1906 broadcast:

"The program on Christmas Eve was as follows: first a short speech from me saying what we were going to do, then some phonograph music. Then came a violin solo by me, a composition of Gounod called 'O Holy Night,' and ending up with the words 'Adore and be still' of which I sang one verse, in addition to playing on the violin, though the singing of course was not very good. Then came the Bible text 'Glory to God in the highest and on earth peace to men of good will' and finally we wound up by wishing them a Merry Christmas and then saying that we proposed to broadcast again on New Year's Eve."

The transmitter was a rotating high-frequency ac generator, operating at about 80 kc. The antenna was an "umbrella" type on a tower 400 feet high.

"Closed-Circuit TV" Across Narragansett Bay

Classroom TV has been extended by the University of Rhode Island to include a classroom at the Raytheon anti-submarine and undersea warfare center at Portsmouth. While the university's on-campus students receive face-to-face instruction, the students across the bay get the same courses through "closed-circuit" television.

The distance between professors and students is about 14 miles. The microwave link operates from the water tower at the university to the Raytheon water tower on its premises at Portsmouth. A "beam bender" on that tower reflects the signal down to a dish antenna mounted on the roof of the building in which classes are held.

Broadcast Pioneer Passes

O. B. Hanson, one of the first broadcast engineers, died Sept. 26 of a heart attack. He was 67 years old.

Deciding on a radio career at an early age, he studied at the Marconi School (now RCA Institutes) in New York City and went to sea as a wireless operator. Later he joined the engineering department of Marconi, becoming chief test engineer in 1918.

During World War I, Mr. Hanson went back to ship wireless operating for a time, and in 1921 joined station WAAM in Newark, N. J., as chief engineer. A microphone of his own design attracted the attention of larger radio stations, and in 1923 he became staff engineer and later plant manager of WEAF, New York (now WNBC). He became chief engineer of National Broadcasting in 1926 and was elected vice president in 1937. He was elected a vice president of RCA in 1954 and remained in that post till his retirement in 1959. Mr. Hanson was a Fellow of the Institute of Radio Engineers, the Acoustical Society of America and the Society of Motion Picture Engineers.

AES Holds Record Convention

The Audio Engineering Society heard an unprecedented number of papers at its annual convention held in New York City Oct. 9–13. More than 100 papers were read to the over 1,000 audio engineers who attended the convention. The sessions on sound reinforcement, tape and disc recording, and stereo FM drew especially large audiences and created lively discussion.

The society presented its annual John Potts Memorial Award to J. K. Hilliard of the Ling-Altec Research Div. of Ling-Temco-Vought, for pioneering achievement in electro-acoustic transducer design. The Emil Berliner Award was bestowed on Roy Dally, phonograph cartridge engineer of the General Electric Audio Products Div., for achievements in electromagnetic disc reproducing transducer design. The Audio Engineering Society Award was presented to Sherman Fairchild, as the person whose work has most helped to advance the Society during the past year.

Officers of the society for the coming year are H. H. Scott, president; H. E. Roys, RCA Victor Record Div., executive vice president; A. B. Clapper, Universal Recording Corp., Central vice president; Wm. H. Thomas, J. E. Lansing Sound, Inc., Western vice president. C. J. LeBel, Audio Devices Inc., secretary, and R. A. Schlegel, Radio WOR, treasurer.

Do-It-Yourself Ionosphere Is Radio Engineers' Plan

A scheme for creating electrically charged clouds in the region between 40 and 250 miles above the earth and sustaining their charge for hours with radio power pumped from below has been announced by a team of Sperry Gyroscope Co. engineers. The charged clouds would make excellent reflectors that could be used to extend the range of TV stations beyond line-of-sight, to act as midpoint reflectors for long-distance radio relays, and even to substitute for satellites in transoceanic broadcasts.

The Signal Corps has set up an artificial cloud of powdered cesium carbonate which was used to bounce a 100-mc signal between Texas and Florida. The reflecting patch lasted only a half hour. The Sperry engineers, though silent for patent reasons on the details of their plan, believe they could ionize such a cloud from below without using impractical amounts of power.

No Stereo AM, Says FCC

There is little evidence of public need or desire for AM stereo, the FCC stated in turning down petitions from Philco, RCA and Kahn Research Laboratories, who wished to see standards established for an AM stereo system.

An AM stereo system with sufficient separation and without bad side effects would be much harder to realize than was the case with FM, the commission pointed out. Also, the pattern of operation and the needs and purposes served by the nearly 4,000 AM stations are such that the beneficial effects of such an innovation as stereo would be small.

Rf Breaks Rocks

Radio frequency can break up rock as effectively as explosives and can be as much as 25 times as economical according to a recent test report from General Electric.

The new process depends on the often-overlooked fact that "solid" rock contains as much as 5% water. Trapped in the crystalline structure of the rock, it can be reached and heated by electricity. A source of high-energy rf is applied to the rock through electrodes. Once a current-carrying path is established, it reduces the internal resistivity of the rock, making it possible to increase the power. The resulting heat, or "thermal stress," splits the rock along the path of conductivity.

General Electric estimates that a source of current in the 20–40-mc range with a power output of about 25 kilowatts will be suitable for a commercial rock-breaking system. The practical feasibility of the process was tested by General Electric in cooperation with the Montana School of Mines.

Radar "Angels" Have Wings

The "angels" on radar screens—those mysterious blips that have puzzled scientists and radar operators for years—are (as ornithologists have suspected for a number of years) migrating birds. This solution of a 20-year-old problem was proposed by three ornithologists in the October, 1961, issue of *Natural History*, a publication of the American Museum of Natural History. In experiments on the coast of Massachusetts, filters designed to remove objects the size of migrating birds filtered the "angels" out completely.

Besides solving a puzzle that was first posed when British operators noted the strange blips on their

NOW! HERE'S YOUR CHANCE TO QUALIFY AS AN EXPERT IN ELECTRONICS & COMMUNICATIONS!

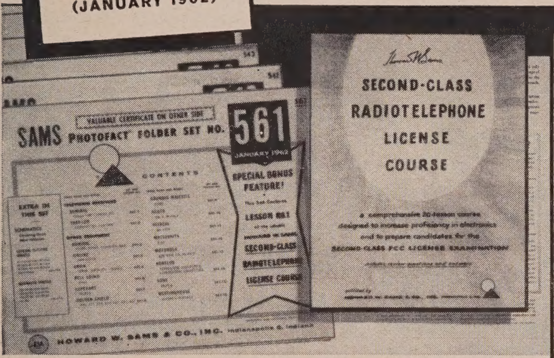
ANNOUNCING A COMPLETE, PRACTICAL, UP-TO-DATE 20-LESSON

"SECOND-CLASS RADIOTELEPHONE LICENSE COURSE"

AVAILABLE AS AN EXCLUSIVE BONUS FEATURE TO

PHOTOFACT® SUBSCRIBERS!

DON'T MISS IT!
FIRST LESSON IN
PHOTOFACT SET No. 561
(JANUARY 1962)



TO HELP YOU PASS THE F.C.C. LICENSE EXAM—HERE'S THE COMPLETE COURSE YOU GET WITH YOUR PHOTOFACT SUBSCRIPTION:

- **Lesson 1.** Introduction to Communications Electronics
- **Lesson 2.** Services and Frequency Assignments
- **Lesson 3.** Radio Communications Systems
- **Lesson 4.** Laws, Licensing, and Operating Practice
- **Lesson 5.** Class C Amplifiers
- **Lesson 6.** Oscillators and Multipliers
- **Lesson 7.** Antenna Systems
- **Lesson 8.** Microphones and Audio Amplifiers
- **Lesson 9.** FM Modulation Principles
- **Lesson 10.** AM Modulation Principles
- **Lesson 11.** Power Sources
- **Lesson 12.** Detectors
- **Lesson 13.** Receiving Systems
- **Lesson 14.** Two-Way Radio Circuit Descriptions (FM)
- **Lesson 15.** Two-Way Radio Circuit Descriptions (AM)
- **Lesson 16.** Test Equipment
- **Lesson 17.** Basic Transmitter Tuning Procedures
- **Lesson 18.** Citizens Band Installation and Adjustment
- **Lesson 19.** Two-Way Radio Installation and Adjustment
- **Lesson 20.** Two-Way Radio Maintenance and Guidance for FCC Examinations

PLUS—carefully-designed Questions and Answers to help reinforce your learning!

YES! YOUR PHOTOFACT SUBSCRIPTION CAN HELP YOU EARN A 2ND-CLASS LICENSE WHICH:

1. Upgrades your professional status in electronics...the Federal Government License is a nationally recognized "diploma" of proficiency...gains the recipient immediate respect as a qualified electronics technician.
2. Automatically identifies you as an expert in electronics... qualifies you to install, maintain and operate two-way communications equipment.

The two-way and CB radio market is expanding at a tremendous rate. Well over 1,500,000 transmitters (industrial, aviation, public safety, CB, etc.) are now licensed, with approximately 400,000 new license applications yearly. To help you get your share of this profitable new business, Howard W. Sams offers you with your PHOTOFACT subscription, his Second-Class Radiotelephone License Course that can be worth hundreds of extra dollars to you yearly!

SUBSCRIBE NOW—Get This Timely BIG BONUS Course!

DON'T MISS A SINGLE ISSUE! **Enter your subscription with your Sams Distributor today to receive all PHOTOFACT Sets as issued each month. Beginning in January, 1962, you will start receiving the 20-Lesson Second-Class Radiotelephone License Course as a bonus with your subscription!**

SUBSCRIBE TODAY!

as SEEN in TV GUIDE

Now! Powerful National Advertising Builds Prestige and Business for "PEET" Members!

TV GUIDE now carries each month to 7,500,000 TV families the "PEET" (Photofact-Equipped Electronic Technician) Program message...to build dynamic support and demand for the services of "PEET" members. There's never been a national ad program like this for the electronic servicing profession—with so many valuable tie-in promotional aids!

NOW MORE THAN EVER, IT PAYS TO QUALIFY AS A "PEET" MEMBER!

Howard W. Sams & Co., Inc., Dept. 6-M1
1724 E. 38th St., Indianapolis 6, Ind.

☐ **I would like to enter my subscription to Photofact, effective with Set No. 561**

My Distributor is:__________

☐ Send me details on how to become a "PEET" Member

Shop Name__________

Attn.__________

Address__________

City__________Zone_____State______

screens in 1940 and 1941, the scientists believe they have added a new tool in the study of bird migrations. Already they have discovered that the actual patterns of migratory birds are often quite different than they appear to a ground observer.

Calendar of Events

EIA Winter Conference Nov. 28–30 Statler Hilton Hotel, Los Angeles, Calif.
IRE Conference on Vehicular Communications, Nov. 30-Dec. 1, Hotel Radisson, Minneapolis, Minn.
IRE, AIEE, ACM Eastern Joint Computer Conference, Dec. 12–14 Sheraton Park Hotel, Washington, D.C.
National IRE, AIEE, ASQC and EIA Symposium on Reliability and Quality Control, Jan. 9–11, Statler Hilton Hotel, Washington, D.C.
ERA Annual Convention, Jan. 23–27, Hollywood Beach Hotel, Hollywood Beach, Fla.

Copper Hairs Into Space

A 75-lb. air force instrument package spewed three hundred and fifty million tiny copper hairs into orbit around the earth Oct. 21. Arranged in a band 2100 miles up, the little wires, about a third the thickness of a human hair and only 0.7 inch long, are expected to act as tiny dipole antennas for reflecting radio signals. Tests of 8,000-mc signals between radar antennas at Parks Air Force Base in California and Millstone Hill, Westford, Mass., via the copperwire belt will be made during the anticipated 3-year useful life of the particles.

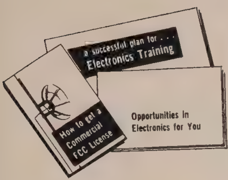
Klystron Inventor Killed

Sigurd F. Varian, co-inventor of the klystron tube, was killed in a recent plane crash in the Pacific about a mile off the coast of Mexico. Mr. Varian, with his late brother Russell and Dr. William Hansen, founded Varian Associates in Palo Alto, Calif., to develop and manufacture microwave components. The klystron tube, developed as a detector of microwaves in 1939, led to the development of microwave radar as one of the vital weapons in the defense of Britain during World War II.

Third Consol Station Coming

The Federal Aviation Agency announces that it is installing a Consol station at Miami, Fla. Consol is the principal long-range radio navigation aid operated by the FAA serving air traffic outside the United States. It and Consolan (RADIO-ELECTRONICS, March 1961) are two forms of the same system, a direction-finding technique that requires only a radio tunable to its frequency and a Consolan chart.

There are two earlier Consolan stations in the United States, one at Nantucket and one at San Francisco. Besides being used by planes, small-boat owners find them valuable. One use in marine navigation, for example, is to aid commercial fishermen. Nantucket fishers report that they put out their pots along a radial of the Nantucket Consolan, and are able to retrieve them easily by going back along the same line. END



FREE

Completion of the Master Course (both Sections) will prepare you for a First Class Commercial Radio Telephone License with a Radar Endorsement. Should you fail to pass the FCC examination for this license after successfully completing the Master Course, you will receive a full refund of all tuition payments. This guarantee is valid for the entire period of your enrollment agreement.

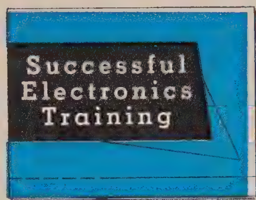
Your FCC Commercial License -or your money back!

FREE

"License and $25 raise due to Cleveland Institute training"

"I sat for and passed the FCC exam for my second class license. This meant a promotion to Senior Radio Technician with the Wyoming Highway Department, a $25 a month raise and a District of my own for all maintenance on the State's two-way communication system. I wish to sincerely thank you and the school for the wonderful radio knowledge you have passed on to me. I highly recommend the school to all acquaintances who might possibly be interested in radio. I am truly convinced I could never have passed the FCC exam without your wonderful help and consideration for anyone wishing to help themselves."

CHARLES C. ROBERSON, Cheyenne, Wyoming



Investigate Our NEW Training Program in Computer, Servo-Mechanisms, Magnetic Amplifiers and Others

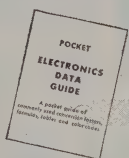
find out how . . .

1. You can get job security. Specialized education is the road to higher salary and important jobs in the growing field of electronics.
2. You can solve the problems that stump other technicians. Problems in electronics are becoming more complex. Your ability to solve problems will help you get ahead in your field.
3. You can handle new electronic devices. Every day, advances are being made in electronics. Only through education can you find out how to keep up with these developments and how to use the new devices.

Accredited by National Home Study Council

Get This Handy Pocket Electronics Data Guide Folder

FREE



Puts all the commonly used conversion factors, formulas, tables, and color codes at your fingertips. Yours absolutely free if you mail the coupon today. No further obligation!

Sorry-Not For Beginners

Please inquire only if you really want to get ahead and to add to what you have already learned in school, in the service, or on the job. Some previous schooling or experience in electronics, electricity, or related fields is necessary for success in Cleveland Institute programs.

TO GET THIS FREE GIFT, MAIL COUPON TODAY!

Cleveland Institute of Electronics

1776 E. 17th Street RE 60B Cleveland 14, Ohio

Cleveland Institute of Electronics

1776 E. 17th Street, Desk RE60B, Cleveland 14, Ohio

Please send free career information material prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below.

- ☐ Military
- ☐ Radio-TV Servicing
- ☐ Manufacturing
- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other

In what kind of work are you now engaged?..

....

In what branch of Electronics are you interested?..

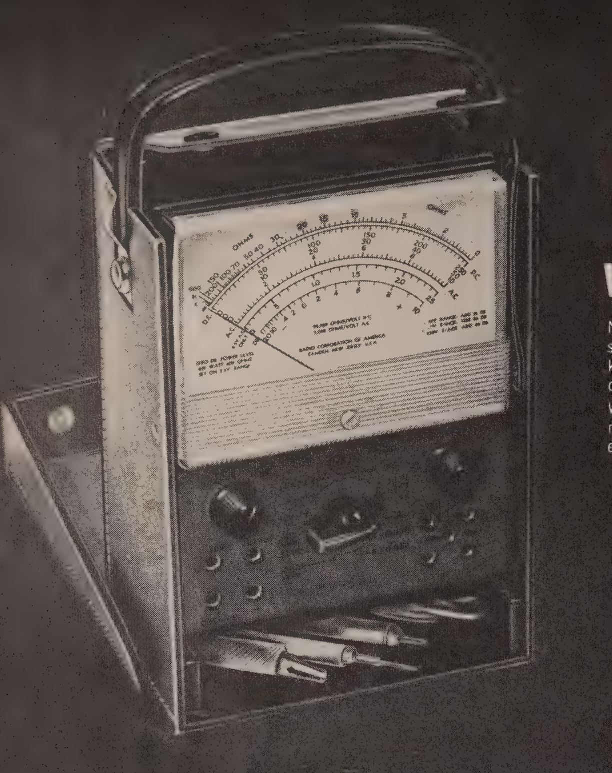
....

Name.. Age..........

Address..

City.. Zone...... State..........

RE 60B



Get Extra Value at No Extra Cost

with this RCA WV-38A (K)

VOLT-OHM-MILLIAMMETER KIT

Now you can get a professional-caliber V-O-M in kit form. Enjoy the self-satisfaction and sensible savings that kit assembly offers you. No professional know-how required. Clear step-by-step directions to follow. The result: years of precision service at low cost.

Whatever your reason for choosing a V-O-M kit, there's one basic reason for making that choice an RCA WV-38A (K)... **extra value** at no **extra cost**. Want examples?

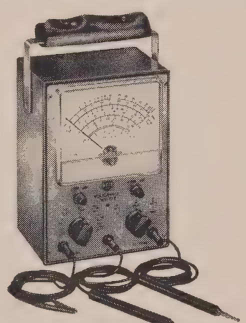
- Extra 0.25-volt and 1-volt ranges
- Frequency response of low a-c ranges is flat within 1 db to 800,000 cycles
- Spring clips on handle for extra carrying convenience
- Jacks below switches keep leads out of way
- DB scale clearly marked; no squinting
- Easy-to-read meter measures 5" wide
- Non-breakable, sealed plastic window
- Red test lead has probe and slip-on alligator clip for added versatility

RCA WV-38A available factory-wired and calibrated: $43.95*

ONLY **$29.95***

Attractive, scuff-resistant laminated-vinyl carrying case, $4.95* extra

OTHER OUTSTANDING RCA KIT VALUES



RCA WV-77E (K)

VOLTOHMYST® KIT

Famous VoltOhmyst® quality and performance at a low price! Special test features include: separate 1.5-volt rms and 4-volt peak-to-peak scales for accurate low AC measurements. Tests AC and DC voltages to 1500 volts; resistance from 0.2 ohm to 1000 megohms. Complete with ultra-slim probes, long flexible leads, special holder on handle to store leads.

ONLY **$29.95***

RCA WV-77E available factory-wired and calibrated: $43.95*

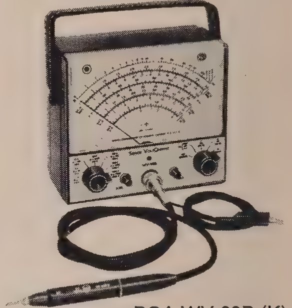
RCA WO-33A (K)

SUPER-PORTABLE OSCILLOSCOPE KIT

Here is a rugged, compact oscilloscope that weighs only 14 pounds. Easily portable for in-the-home or shop troubleshooting. Ideal for servicing black-and-white and color TV, radio, hi-fi components, tape recorders, etc. Ample gain and bandwidth for the toughest jobs. 3" graph-scale screen and internal calibrating voltage source for direct reading of peak-to-peak voltage.

ONLY **$79.95***

RCA WO-33A available factory-wired and calibrated: $129.95*



RCA WV-98B (K)

SENIOR VOLTOHMYST® KIT

A real money and time saver... now available in kit form! The etched-circuit-board and AC/DC ohms probe are pre-assembled. Separate color-coded scales measure DC voltages, 0 to 1500 volts; AC voltages, 0 to 1500 volts rms or 4200 volts peak-to-peak. Resistance from 0.2 ohm to 1000 megohms. 200-microampere meter movement with less than 1% tracking error. Precision multiplier resistors accurate to ± 1%.

ONLY **$62.50***

RCA WV-98B available factory-wired and calibrated: $79.50*

Call your Authorized RCA Test Equipment Distributor

*User Price (Optional)

RCA The Most Trusted Name in Electronics

RCA Electron Tube Division Harrison, N. J.

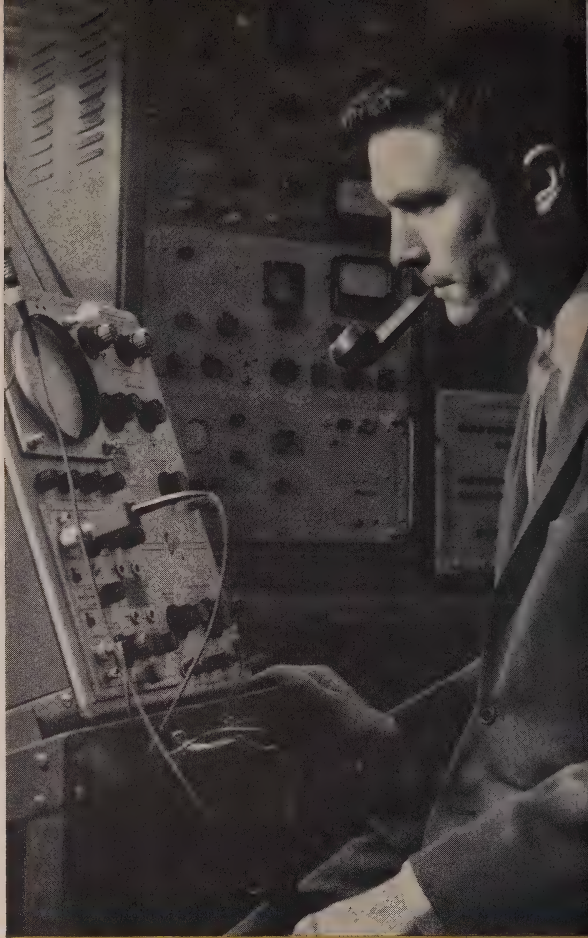
Profiles in Electronic Engineering Technology

CREI

"a CREI home study program helped me become an electronics engineer—

Through a CREI Home Study Program I learned the practical theory and technology I needed to become a fully-qualified engineer—not a 'handbook' engineer either—and I did it while I was on the job."

Robert T. Blanks
Engineer, Research & Study Division
Vitro Laboratories, Silver Spring, Md.
Division of Vitro Corporation of America



HELPS YOU ON THE JOB *Electronics Engineer Robert T. Blan applies knowledge learned in his CREI Home Study Program tough research problems at Vitro Laboratories.*

INDUSTRY-RECOGNIZED CREI HOME STUDY PROGRAMS PREPARE YOU FOR INCREASED RESPONSIBILITIES, CHALLENGING POSITIONS IN ELECTRONICS

When you enroll in the CREI Home Study Programs, you jo more than 20,500 students who are presently working in alm every phase of electronics in all 50 states and most countries the free world. You study courses to which a number of toda leading engineers and scientists have made substantial cont butions. You are guided and assisted by CREI's staff of expe enced instructors.

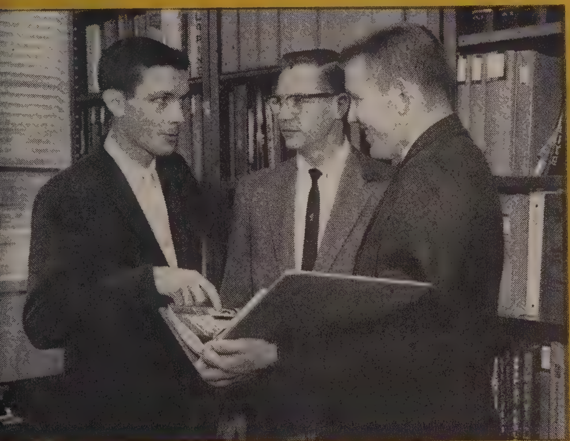
Demand for CREI-prepared men today far exceeds the supply has exceeded the supply for many years. CREI Home Stu Programs are specifically designed to prepare you for responsi positions in the electronics industry. In addition, *CREI Ho Study Programs are kept up to date to include latest advanceme in electronics.* We invite you to judge the Programs for yours Check the thoroughness and completeness of CREI Home Stu Programs in the catalog provided upon request. These Progra include:

INTRODUCTION TO ELECTRONIC ENGINEERING TECHNOLOGY · ELE TRONIC ENGINEERING TECHNOLOGY · SPECIALIZED COMMUNICATIO ENGINEERING TECHNOLOGY · SPECIALIZED AERONAUTICAL AND NA GATIONAL ENGINEERING TECHNOLOGY · SPECIALIZED TELEVISI ENGINEERING TECHNOLOGY · SPECIALIZED SERVOMECHANISMS A COMPUTER ENGINEERING TECHNOLOGY · SPECIALIZED ENGINEERI MATHEMATICS · AUTOMATION AND INDUSTRIAL ELECTRONICS · EN NEERING TECHNOLOGY · NUCLEAR ENGINEERING TECHNOLOGY

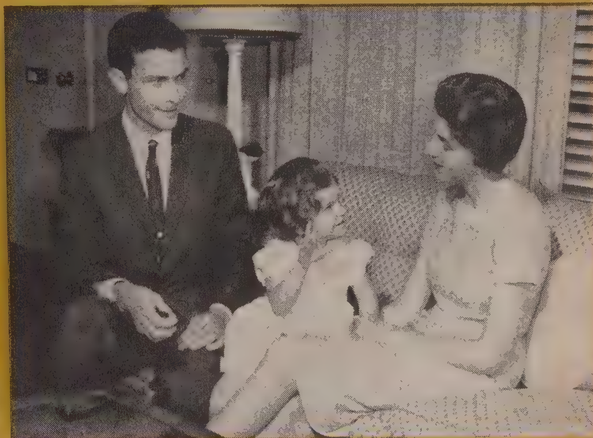
The high calibre of a CREI Home Study education is attested by America's biggest corporations, where CREI students a alumni attain positions ranging from engineering technicians

EMPLOYERS ARE QUICK *to recognize the value of your enrollment in CREI Home Study Programs—to your company as well as to yourself. Often promotion comes before you complete your studies. Here Engineer Robert Blanks discusses CREI with Director Wayne G. Shaffer of Vitro Laboratories.*

YOUR LIVING IS BETTER *when you prepare yourself for—and get—desired promotions and advancements through CREI Home Study Programs. CREI alumnus Robert Blanks, shown relaxing on his front lawn with his dog, is understandably proud of his fine home in a comfortable suburban neighborhood.*



YOU EARN NEW RESPECT *Your CREI acquired knowledge helps you form new associations, makes you more valuable on the job. Engineer Blanks talks with Technician Robert I. Trunnell, a CREI Home Study alumnus and John H. Scofield Mathematician, a current CREI Home Study student—all of Vitro Laboratories.*



YOUR WHOLE FAMILY BENEFITS *from your CREI Home Study Program. Everyone in Engineer Blanks' growing family pitched in to provide him with free time at home to pursue his CREI studies. Now they share in his success.*

engineers to top officials. Such companies are National Broadcasting Company, Pan American Airways, Federal Electric Corporation, The Martin Company, Northwest Telephone Company, Mackay Radio, Florida Power and Light, and many others. These companies not only recognize CREI Home Study educational qualifications but often pay all or part of CREI tuition for their staff members.

CREI Home Study Programs are the product of 34 years of experience; CREI itself was among the first to have its curricula accredited by the Engineers' Council for Professional Development. Each program has been developed with the same painstaking skill and care that CREI put into its World War II electronics courses for the Army Signal Corps, its special radio courses for the Navy, and its post-war group training programs for leading companies in aviation and electronics. For those who can attend day or evening classes in person, CREI maintains a fully accredited ECPD Technical Institute Residence School Program in Washington, D. C.

REQUIREMENTS FOR ENROLLMENT Pre-requisite is a high school education or equivalent *plus* basic electronics training and/or practical electronics experience. (Electronics experience and/or training not necessary for Residence School.) If you qualify, send for the latest CREI catalog and full information at no cost. Veterans may apply under the G.I. Bill. If you're doubtful about your qualifications, let us check them for you. Mail coupon to: The Capitol Radio Engineering Institute, Dpt. 1412-H, 3224 Sixteenth St., N.W., Washington 10, D. C.

MAIL COUPON TODAY FOR FREE 58-PAGE BOOK

CAPITOL RADIO ENGINEERING INSTITUTE — CREI — FOUNDED 1927

THE CAPITOL RADIO ENGINEERING INSTITUTE
Founded 1927—ECPD Accredited
Technical Institute Curricula
Dept. 1412-H, 3224 Sixteenth St., N.W.
Washington 10, D.C.

Please send me details of CREI Home Study Programs and Free Book, "Your Future in Electronics and Nuclear Engineering Technology." My qualifications are noted to obtain immediate service.

CHECK FIELD OF GREATEST INTEREST:
- ☐ Servo and Computer Engineering Technology
- ☐ Electronic Engineering Technology
- ☐ Aero and Navigational Engineering Technology
- ☐ Automation and Industrial Electronic Engineering Technology
- ☐ Nuclear Engineering Technology

Employed by________________

Type of present work________________

Education: Years High School________ Other________

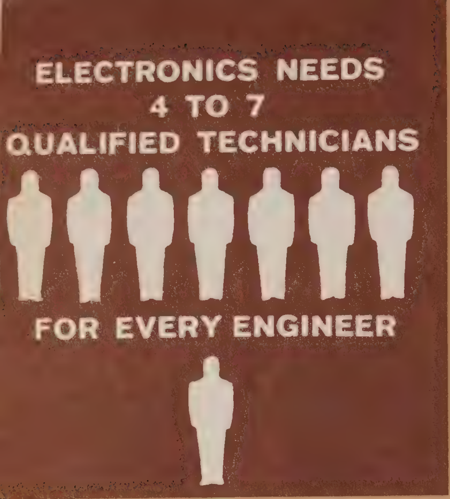
Electronics Experience________________

Name________________ Age________

Address________________

City________________ Zone________ State________

Check: ☐ Home Study ☐ Residence School ☐ G.I. Bill



Join The Thousands Who Trained For Advancement With NRI

Thousands of NRI graduates throughout the U. S. and Canada are proof that it is practical to train at home. NRI graduates are in every kind of Electronics work: inspectors, maintenance men, lab technicians, testers, broadcasting and mobile communications operators, Radio-TV service technicians, or in essential military and government posts. Catalog tells more about what NRI graduates do and earn. Mail postage free card.

Choose from 4 Courses

1 INDUSTRIAL ELECTRONICS
Learn Principles, Practices, Maintenance of Electronic equipment used today by business, industry, military, government. Covers computers, servos, telemetry, multiplexing, many other subjects.

2 FCC LICENSE
Every communications station must have one or more FCC-licensed operators. New NRI course is designed to prepare you for your First Class FCC exams. You learn quickly, training at home in your spare time.

3 COMMUNICATIONS
Training for men who want to operate and maintain radio and TV stations; police, marine, aviation, mobile radio, etc. Includes FM Stereo broadcasting. Course also prepares you for your FCC license exam.

4 SERVICING
Learn to service and maintain AM-FM Radios, TV sets, Stereo Hi-Fi, PA systems, etc. A profitable, interesting field for a spare-time or full-time business of your own.

SEE OTHER SIDE

"THE FINEST JOB I EVER HAD" is what Thomas Bilak, Jr., Cayuga, N. Y., says of his position with The G. E. Advanced Electronic Center at Cornell University. He writes, "Thanks to NRI, I have a job which I enjoy and which also pays well."

BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."

"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRLD-TV.

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."

FROM FACTORY LABORER TO HIS OWN BUSINESS that rang up sales of $158,000 in one year. That's the success William F. Kline of Cincinnati, Ohio, has had since taking NRI training. "The course got me started on the road," he says.

FIRST CLASS
PERMIT
NO. 20-R
(Sec. 34.9, P.L.&R.)
Washington, D.C.

BUSINESS REPLY MAIL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

POSTAGE WILL BE PAID BY

NRI
National Radio Institute
3939 Wisconsin Avenue
Washington 16, D.C.

NRI IS OLDEST—LARGEST SCHOOL OF ITS KIND

Training men to succed by home study has been the National Radio Institute's only business for over 45 years. NRI is America's oldest and largest Electronics home-study school. Don't delay. Cut out and mail POSTAGE-FREE CARD.

MAIL POSTAGE-FREE CARD

Correspondence

COMPETITION VS. COMPETENCE

Dear Editor:

A New York-to-Miami vacation trip in mid-August with two young children kept my eyes on TV nightly. Mostly on a different receiver each evening.

The one constant thing in almost all locations was the poor condition of the TV receivers in most motel rooms. In all too many cases, one was left with a poor impression of the service technician's competence. Defects more commonly found were poor raster linearity, misadjusted hold, agc and size. Some of these can easily be attributed to tube aging and line-voltage variations. Others, such as a tilted raster, can only be blamed on sloppy servicing.

The worst examples were found in a Florida town where local distributors have discount sales limited to authorized service organizations.

The enforcement of this policy is so strict that local electronic manufacturer(s) allow their employees to purchase tubes and components from the company stock. An accounting system makes deductions from the payroll. Special parts usually require a 100-mile round-trip to another city.

One thought immediately comes to mind—which came first: poor service or strict regulation? Since the system has been in effect for several years, poor service should have disappeared long ago, if the claim that restriction would keep incompetents and tyros out of the field were true. Apparently what *has* happened is that competition has been strangled to such an extent that the quality of service is not a competitive quantity any more.

ELMER C. CARLSON
New York, N. Y.

INVENTOR STRIKES BACK

Dear Editor:

The August issue's News Briefs on "How Cathode Heats in 1/10 Second" may describe a new *fast-heating* tube, but the cathode's 1.6 volts is *not* "the closest approximation to the unipotential cathode yet achieved in a filament."

Way back in the mid-Twenties, Western Electric produced the VT-1 at about 1.5 volts; RCA produced the WD-12 tube which worked very well below 1.5. (See my Sept. 22, 1926, paper before the Radio Club of America, and the March 1927 issue of *Radio Broadcast.*) About this same time, the Armstrong Co. of Newark, N. J. produced my "AC 100 Tube," with a straight, oxide-coated, nickel filament operating at 0.7 to 0.8 volt and about 2.5 amperes, and usable in the detector stage of a radio receiver because of its very low ac hum.

This tube was described and demonstrated before the Radio Club of America at Columbia University on May 18, 1927, and published in its *Proceedings* later and also in *Radio Broadcast* for September 1927.

The very low voltage-effect hum of this tube was neutralized by its magnetic-effect hum (180° out of phase) at a filament voltage of about 0.7. Its heavy, high-thermal-inertia (nickel) filament reduced its temperature modulation, at double the ac energizing frequency, to the vanishing point. About 6 months after this tube appeared on the market (and was scoffed at by RCA and others of the Patent Pool), RCA brought out a 1.5-volt ac tube (the 226) using the same principles of hum suppression, and a few years later they bought my entire portfolio of socket-powered radio patents and some 22 outstanding licenses.

Your news item's last "cuts hum" statement is hard to believe. Those "very fine" filament wires of the harp cathode will surely have a strong 120-cycle temperature and emission modulation, which neither their voltage-effect nor magnetic-effect hums can possibly neutralize, because they are out of phase with both.

The magnetic fields of these wires, which deflect their electron streams to the plate into longer paths for each half-cycle of their currents will also produce hum, unless carefully balanced against their voltage-effect hum by design and by rated voltage specifications for *all* electrodes.

BENJAMIN F. MIESSNER
Miami Shores, Fla.

ELECTRONIC IGNITION NOT FOR ME

Dear Editor:

I was rather surprised to see an article like "Electronic Ignition For Your Car" in the September 1961 issue. Admittedly, a transistorized ignition system is a fine project worthy of discussion if it is properly designed. However, proper design involves, among other things, the use of as simple a circuit as possible that will do the job efficiently and reliably. How can a little black box that contains 1 transformer, 2 transistors, 12 resistors, 8 rectifiers, 7 capacitors, 1 thyratron and a thermal relay be considered simple or reliable? There are too many parts to malfunction.

As if this weren't enough, there is a Rube Goldberg buzzer "quick start" and, when this produces undesirable side effects, you file off the leading edge of the distributor rotor. Such articles would be better left to the electronics sections of one of the backyard mechanics magazines. J. S. PITMAN

[This is the second letter of this type we have received this week.

Unfortunately, you seem to be judging a system you have not built or tried and are guessing at its probable performance. This is not enough. I tried and tested the system. It works and works well, despite the "large" number of parts you quote. Incidentally, the common ac–dc table radio has many more parts than this ignition system, yet it regularly operates for years without needing repairs. If you scale this down, the ignition system should work for decades. It's got fewer parts to go wrong.

The quick-start buzzer is not a Rube Goldberg device. It works and works well. If you or any other reader can suggest a better method, we'd be happy to learn of it. If filing down the distributor rotor (I didn't have to) is necessary, it's no different from adjusting the gap on a spark plug so the plug functions properly.

What has been overlooked is that the electronic ignition system has definite advantages over mechanical systems. Better and surer firing, better gas mileage and better pickup and high-speed operation are examples. Also, plugs last longer and points do not pit as rapidly when an electronic ignition system is used.

As a final point, these "complicated" electronic systems are often used in race cars. Here, where a system really gets a workout, they are not considered too prone to failure to make them impractical, so why should they be impractical for your car?—*Larry Steckler, Associate Editor*]

WRONG CONTROLS

Dear Editor:

The "Quality Stereo Preamp" by W. R. Williams that appeared in the October 1961 issue should prove a worth-while do-it-yourself project for the nimble-fingered home builder.

Mr. Williams was kind enough to use Centralab controls and lists part numbers for purchasing ease. However, the types he lists for R31 and R32 are not correct. The "B" controls he indicated have solid ¼-inch shafts and cannot be used as part of a dual concentric assembly. The parts that should be specified are: R31, 1 megohm, 500,000-ohm tap, linear taper (part F1-56). R32, 1 megohm, 500,000-ohm tap, linear taper (part R2-56).

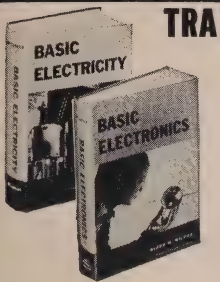
For additional ease in construction, may we suggest using our SR-70 stereo-twin control for R34. It will eliminate the need for soldering stiffeners between R32 and R34. Unfortunately, we cannot provide a simpler solution for soldering the shaft of R33 to the rear of R31.

We have made up a list of the correct parts numbers along with the suggestion for simplifying the assembly of the loudness control for the benefit of any of your readers who may desire it.

R. E. ANDERSON
Merchandising Assistant
Centralab
Milwaukee, Wis.

END

TRAINING YOU NEED in its most complete economical and easily understood form



TRAIN AT HOME FOR TV-RADIO-ELECTRONICS . . . at rock-bottom Cost!

Get your basic training from these two easily understood, low cost books!

Here is complete basic electrical-electronic training specifically written for beginners—priced at a fraction of what you might expect. 785 pages and almost 700 pictures, diagrams and charts in these two big books bring you top notch training that can pave your way to a fascinating electronic career. Every detail is fully and clearly explained. Nothing is omitted—nothing is condensed. In every respect, the material in these books compares more than favorably with "courses" costing many times as much!

BASIC ELECTRICITY—Fundamental electrical principles are the basis of all Electronics—and this 396-page manual gives you a complete working knowledge of them all! Covers everything from electromagnetism to 'phone principles, circuits, wiring, illumination, reactance, impedance, power factor, instruments, controls, measurements, and all types of components and equipment. Includes set-up diagrams, practical examples and problem solutions. Price $6.25 separately. See Money-Saving Offer!

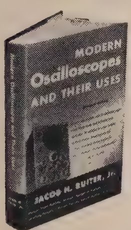
BASIC ELECTRONICS—This new 389-page guide takes up where Basic Electricity leaves off. Shows how electrical principles are applied in Electronics and gives you a sound grasp of electronic theory, methods, circuits and equipment. Over 375 illustrations explain details clearly. The ideal basic training to help you build a profitable future in TV, radio, communications, hi-fi, industrial electronics and related fields! Price $6.25 separately.

Save $1.50! See special Money-Saving Offer in Coupon!

ONLY $11.00 FOR THIS COMPLETE HOME TRAINING!

Here's everything you need to know about OSCILLOSCOPES!

Complete data on using the handiest instrument of all!

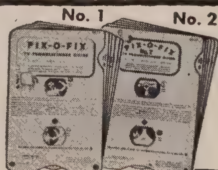


Men who know how to use oscilloscopes on all types of jobs don't guess about troubleshooting and tough realignment problems! They locate troubles in a jiffy, adjust them quickly and accurately—and this famous 346-page manual teaches you the methods they use.

'Scope experts get the big pay jobs!

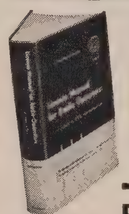
MODERN OSCILLOSCOPES AND THEIR USES gets right down to earth in telling you all about these versatile instruments and exactly how to use them. Particular attention is paid to AM, FM, and TV realignment procedures. Every detail of testing with 'scopes is explained from connecting the 'scope and setting its controls to adjusting components in the chassis being tested. Illustrated instructions teach you to analyze patterns. Even includes data on quantitative measurements (as used in color TV servicing) and use of 'scopes in lab, industrial electronics and atomic work. 370 illustrations. Price $8.00.

Specify MODERN OSCILLOSCOPES AND THEIR USES in coupon to order.



SHORT CUT TO TV REPAIR!

Just turn the dial of the pocket-size PIX-O-FIX TROUBLE FINDER GUIDE! When the picture in the PIX-O-FIX window matches the image on the TV screen—presto!—you've got your clue. PIX-O-FIX shows the likely causes of the trouble—indicates the receiver section involved—then gives clear repair instructions. Two PIX-O-FIX units Nos. 1 and 2 cover 48 different TV troubles. Together, they're a comprehensive guide to quick "picture analysis" servicing of any TV. Price only $3.00 for the two.



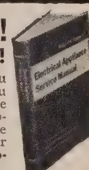
Get your COMMERCIAL OPERATORS LICENSE!

Train for radio's most fascinating, best paid jobs!

This famous book makes it easy to train for your FCC commercial license as an operator aboard ship, in aviation, broadcasting, telecasting, etc. LICENSE MANUAL FOR RADIO OPERATORS is a quick, easily understood guide that covers *ALL EIGHT* FCC examination elements—not just some of them. Reviews almost 2200 exam questions. Covers everything you'll need to know to pass your examination for 1st or 2nd class radio-phone license holder with flying colors! Price $6.75.

REPAIR ANY ELECTRICAL APPLIANCE!

Save on repair bills! . . . Earn in your Spare Time!



This 370-page ELECTRICAL APPLIANCE SERVICE MANUAL helps you service practically any home electrical appliance. Includes standard and automatic washers, ironers, irons, hotplates, hot pads, coffee makers, waffle irons, water heaters, toasters, ranges, cleaners, mixers, razors, clocks, motors, and many more.

Troubleshooting charts quickly help you locate troubles. Easy instructions guide you in making repairs. Tells how to make your own low-cost test tools. Includes appliance refinishing methods. An ideal guide for fixing your own appliances or for building a profitable full or part time appliance repair business! $6.25.

New! Master Guide to TIME-SAVING TV SERVICE

Almost regardless of set make or model this remarkable new 302-page HANDBOOK OF TV TROUBLES helps you track down TV troubles from the symptoms they produce in the set itself: screen intermittently dark; "blooming"; abnormal contrast; "snow"; poor detail; sync troubles; sound troubles—and all the many other symptoms that indicate something is wrong. Just turn to the "Quick Trouble-Finder Guide" inside the cover. Look up the symptoms exhibited by the set you're working on. The HANDBOOK then tells you just what to do and how to do it. Outlines time-saving shortcuts. Eliminates guess-work. More than 150 test patterns, wave form and circuit illustrations explain test results, details and procedures. Printed in large type and bound in sturdy varnished covers for use at the bench. All methods presented have been bench-tested by the author through actual shopwork! Price $7.50.

LOOK! LISTEN!
Then follow this easy guide!

Order HANDBOOK OF TV TROUBLES in coupon.

ORDER NOW!

TRY ANY BOOK 10 DAYS FREE!

Dept. RE-121, Technical Division, **623900**
Holt, Rinehart & Winston, Inc.,
383 Madison Ave., New York 17, N. Y.

Send books checked for 10 day FREE examination at prices indicated plus postage. SAVE! Send cash with order and we pay postage. Same 10 day return privilege with money refunded.

☐ Check here for **MONEY-SAVING SERVICE COMBINATION** on Ghirardi's Radio & TV CIRCUITRY & OPERATION and Radio & TV TROUBLESHOOTING & REPAIR. Price only $17.00 for both (plus postage). Regular price $19.00—**you save $2.00! (#709006)**

☐ Check here for **MONEY-SAVING Basic Training COMBINATION** ON BASIC ELECTRICITY and BASIC ELECTRONICS. Price only $11.00 plus postage for both big books. Regular price—$12.50—**you save $1.50! (#709196)**

Check here to order INDIVIDUAL BOOKS

- ☐ **Radio & TV CIRCUITRY & OPERATION (#708214) ....$ 9.00**
- ☐ **Radio & TV Receiver TROUBLE-SHOOTING and REPAIR...... 10.00 (#708578)**
- ☐ **Basic Electronic Test Procedures (#708933) 8.00**
- ☐ **Semiconductor Devices .... 6.95 (#709003)**
- ☐ **Radio Troubleshooter's Handbook (#708297) 10.00**
- ☐ **Basic Electricity (#708859) .. 6.25**
- ☐ **Basic Electronics (#708974)..$ 6.25**
- ☐ **Modern Oscilloscopes & Their Uses (#708818) 8.00**
- ☐ **PIX-O-FIX TV Trouble Finder Guides, Nos. 1 and 2 (#708412) 3.00**
- ☐ **License Manual for Radio Operators (#708537).. 6.75**
- ☐ **Electrical Appliance Service Manual (#708172) .. 6.25**
- ☐ **Handbook of TV Troubles .... 7.50 (#708453)**

OUTSIDE U. S. A. *Add 50¢ to price of each book. Cash with order, but money refunded if books are returned in 10 days.*

Name______________________

Address______________________

City, Zone, State______________________
(Above offers expire Sept. 15, 1962)


EICO® ...UNCOMPROMISING ENGINEERING
BEST BUYS IN SERVICE INSTRUMENTS: everything from Scopes to Probes
DC-5 MC 5" Scope #460 Kit $79.95 Wired $129.50
Also Avail.—5" Push-Pull Scope #425 Kit $44.95 Wired $79.95
Peak-To-Peak VTVM #232 & †Uni-Probe® Kit $29.95 Wired $49.95
VTVM #221 Kit $25.95 Wired $39.95
†Pat. #2,790,051
Dynamic Conductance Tube & Transistor Tester #666 Kit $69.95 Wired $109.95 Complete with steel cover & handle
TV-FM Sweep Generator & Marker #368 Kit $69.95 Wired $119.95
BEST BUYS FOR INDUSTRIAL TESTING: everything from Bridges to Supplies
NEW Metered Variable Auto-Transformer AC Bench Supplies: #1073 (3 amp.) Kit $35.95 Wired $47.95 #1078 (7½ amp.) Kit $42.95 Wired $54.95
NEW Extra-Low-Ripple 6 & 12 Volt Battery Eliminator & Charger #1064 Kit $43.95 Wired $52.95
NEW AC Volt-Watt Meter #260 Kit $49.95 Wired $79.95
1350 Combinations! Series/Parallel R-C Combination Box #1140 U.S. Pat. No. 2954518 Kit $13.95 Wired $19.95
BEST BUYS IN STEREO & MONO HI-FI: everything from Tape Decks to Speakers
Transistorized Stereo/Mono 4-Track Tape Deck Wired Model RP100W Semi-Kit Model RP100K Electronics in Kit form $299.95
An original, exclusive EICO product designed and manufactured in the U.S.A. (Patents Pending)
NEW FM-Multiplex Autodaptor MX99 Kit $39.95 Wired $64.95 Designed for all EICO FM equipment (HFT90, HFT92, ST96) and any other component quality, wide-band FM tuners having multiplex outputs.
NEW FM-AM Stereo Tuner ST96 Kit $89.95 Wired $129.95 Inc. FET
NEW 70-Watt Integrated Stereo Amplifier ST70 Kit $94.95 Wired $149.95
NEW 40-Watt Integrated Stereo Amplifier ST40 Kit $79.95 Wired $129.95
Bookshelf Speaker System HFS1 Kit $39.95 Wired $47.95
BEST BUYS IN "HAM" GEAR: from Transmitters to Code Oscillators
NEW 60-Watt CW Transmitter #723 Kit $49.95 Wired $79.95
90-Watt CW Transmitter #720 U.S. Pat. No. D-184776 Kit $79.95 Wired $119.95
Universal Modulator Driver #730 Kit $49.95 Wired $79.95 Cover E-5 $4.50
Grid Dip Meter #710 Kit $29.95 Wired $49.95
Over 2 MILLION EICO instruments in use. Compare EICO side-by-side critically with products selling for 2 or 3 times more. Buy your EICO right "off the shelf" from 1500 neighborhood dealers coast to coast, most of whom offer budget terms.
EICO 1961 KITS AND WIRED
Over 80 unique products to choose from!
BEST BUYS IN CITIZENS TRANSCEIVERS AND TRANSISTOR RADIOS
EICO, 3300 N. Blvd., L.I.C. 1, N.Y. C-12
☐ Send free 32-page catalog & Distributor's name.
☐ Send Free Schematic of Model No.________.
☐ Send new 36-page GUIDEBOOK TO HI-FI for which I enclose 25c for postage & handling.
Name..
Address..
City.......... Zone .. State..............
Citziens Band Transceivers From: Kit $59.95 Wired $89.95 Superhet; prealigned xmitter osc; match different antennas by variable "pi" network. Single & multi-channel models.
NEW Walkie-Talkie Citizens Band Transceiver #740 Kit $54.95. Wired $79.95. Carrying Case $3.95. Complete with rechargeable leakproof battery & charger. Operates 2500 hours on the battery. U. S.-made by EICO.
Transistor Portable Radio RA6 Kit $29.95 Wired $49.95 Incl. FET
Listen to the EICO Hour, WABC-FM, N. Y. 95.5 MC, Mon.-Fri., 7:15-8 P.M.
Add 5% in the West
© 1961 Electronic Instrument Co. Inc., 3300 N. Blvd., L. I. C. 1, N. Y.

LUNAR RADIO & TV TRAFFIC

. . . The Moon Poses New Problems for Electronics . . .

ON May 25, 1961, President Kennedy, in a special message to Congress, officially proposed that the country—at a cost of $20 billion—send a man to the moon and back by 1970. Congress has endorsed this plan by voting a $1.7 billion budget for the space agency this year. The total US moon expenditure may reach $40 billions, particularly if the program is speeded up, which it well may be.

Since we, as well as the USSR, are now committed to the conquest of the moon (which we soon will people with our nationals), we should look ahead to the years to come.

Neither we nor the Russians are making these moon trips as pleasure excursions. Tremendous practical stakes are involved. To begin with, the moon is the best space station we may have for a long time. From it we can take off for other planets at a vastly reduced energy cost, because the moon's gravitation is only a sixth that of the earth. Thus a 1,000-ton spaceship weighs only 166 tons on the moon, and the energy to launch it into space is only one-twentieth that required on earth.

We will find the most precious and strategic metals, from platinum to beryllium, in great profusion for transshipment to earth in unmanned, radio-guided transports. Mining will be comparatively simple because of the low lunar gravity.

Most of the great optical telescopes will be on the moon where, because of the absence of an atmosphere, visibility is 100% as against 60% on earth. These telescopes will be operated by remote control from earth, and observation will be via TV and resident observers. Similar electronic means will be used for radio astronomy.

As the population of the moon increases and as industries proliferate, radio communication with the earth, spacecraft in transit and electronically guided unmanned transports will multiply at a vast rate. The moon will always depend chiefly on communication with the earth, and all such electronic traffic must be as free as possible from interruption, despite occasional solar storms and other types of interference. Solar disturbances particularly will require new evaluation of our transmitting and receiving techniques in view of our lack of experience in transmitting a dense electronic traffic to and from the moon across the 238,857-mile vacuum of space. In time it probably will be possible to augment radio and TV communication with extra-narrow-band optical-Maser type transmission and reception.

As the moon always exposes the same geographical face to the earth, which turns constantly, radio and TV transmission and reception presents a problem. Ordinarily, moon messages meant for the US could not be received 24 hours a day via direct line of sight, because parts of our western hemisphere will be invisible from the moon for 12 hours in a given day. Such messages, received in the eastern hemisphere, would then have to be relayed from there to the US. Earth messages to the moon are similarly handicapped. They will have to be relayed to a country that faces the moon or be delayed until the earth has turned around again.

Fortunately, by the time the moon is opened up, most messages will probably go via artificial earth-communication satellites which we will put up during the next few years. While they have not been originally designed for lunar messages, there is still time to change their construction slightly so that moon traffic can be relayed to earth via the 50-odd satellites which we will put into orbit soon.

One of the slight inconveniences that man will have to put up with—probably forever—will be the time lag between earth and moon circuits. Radio waves take 1.2 seconds to bridge the 238,857 miles. Hence, when phoning to the moon, 1.2 seconds must elapse for a one-way communication to speed to its destination, and a like time for the answer—a total of 2.4 seconds. This makes for a somewhat slowed-up conversation, but will probably not be too annoying.

Delay becomes serious with a similar conversation to the planet Mars. Here the total elapsed time is 2 minutes and 10½ seconds *for a one-way message;* 4 minutes 21 seconds for a two-way conversation. Consider also that this timing is possible only during "conjunction" of the two planets—35 million miles. At the greatest separation, 248 million miles, the time for a two-way message would be almost 31 minutes!

Coming back to moon communications, let us also consider that the moon will be peopled not only on its always visible side as we see it from earth, but also on the far side that man never sees directly. That means that we have to take measures to *relay* the messages to the visible side opposite the earth. We cannot erect radio transmitters on the back side of the moon to communicate with us directly, because the signals would go out into space, never reaching the earth. *Hence they must be relayed around the moon to transmitters located opposite the earth.* Because there is no ionosphere on the moon, lunar radio transmissions must, it seems, rely on ground waves rather than on reflected waves. Short-range radio relay systems, or very-long-wave systems relying on ground-wave transmission, may be the answer.* This, provided that the moon's upper strata is conductive. We shall not know about this until we have actually contacted the moon, either by robot or manned craft.

Consider the technical aspects and the vastly increased quantity of all the various types of electronic transmission, which in less than 10 years will have multiplied greatly on earth. Then add a new large load to and from the moon. It becomes quite apparent that new techniques must be evoked if the interference and heterodyne problems are not to choke *all* electronic communication. Even today there is a great deal of chaos on many frequencies.

In addition we have the nuisance problem of "strays" or RFI—radio-frequency interference—which often plays havoc with scores of electronic instruments.

It would seem that before long entirely new means of safeguarding the transmission of radio messages, particularly long-distance signals such as those to and from the moon, will have to be invented. It presents a difficult and complex problem in electronics, but we are certain it will be solved. —*H.G.*

---

*See also "Radio on the Moon," RADIO-ELECTRONICS, July 1959.

Merry Christmas — Happy New Year — The Editors

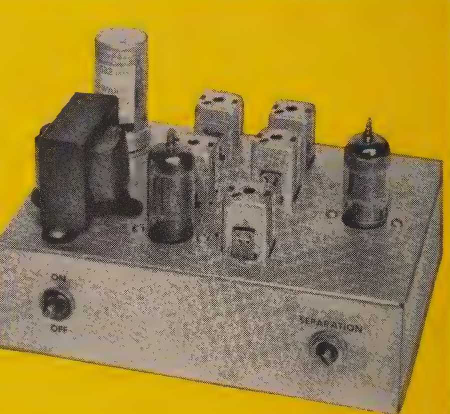
BUILD AN FM STEREO MULTIPLEX ADAPTER

Two-tube unit is easy to put together, works with most wide-band tuners

By DONALD L. STONER

The new stereo FM multiplex system is causing a surge of activity in the FM and hi-fi industry. Manufacturers are busily producing multiplex adapters and integrating this system into complete stereo receivers. The experimenter, too, will be interested in building his own multiplex adapter. It isn't too difficult and can be easily completed on a weekend. It will work with most wide-band FM tuners. If you live in a city with one or more FM stations, check to see which outlets are planning to provide this new service. By the end of the year many stations will be equipped to broadcast stereo FM programs.

This adapter will work with all FM tuners that have a wide-band discriminator or ratio detector. However, it requires an input of at least 0.4 volts. If the input signal is lower the 38-kc oscillator may not lock. At no time should the input signal be greater than about 2 volts. If it is, the L + R signal will ride through with the oscillator signal and cause severe distortion.



Basically the system processes the stereo sources as left and right channels. The signals are combined so that L + R modulates the main carrier in a conventional manner. The L − R signal is used to amplitude-modulate a 38-kc subcarrier. After generating the sidebands, the subcarrier is suppressed and its remaining sidebands also modulate the main channel. A 19-kc pilot subcarrier is generated to phase-lock the reinserted subcarrier in the receiving adapter.

In the receiver, the detector output consists of the L + R audio, the 19-kc pilot subcarrier and the 23- to 53-kc L − R sidebands. Filters separate these sidebands in the adapter, and a 38-kc signal (locked to the 19-kc pilot) is used to recover the original L − R information. The L + R main channel and L − R information is combined in a matrix to separate L and R at the two output terminals. For a more detailed explanation of this complex processing, see the articles "Clear Road for FM Stereo" in the August, and "Stereo FM from Your Own Tuner" in the September issue of this magazine.

A stereo adapter

Fig. 1 is the circuit of a simple two-tube adapter. The MULTIPLEX output of the FM receiver is plugged into J1, the adapter's input. V1-a, half of a 12AU7, amplifies this composite information. The amplified composite signal appears across plate load resistors R9, R10, and is coupled to SEPARATION control R3, through C3, a 0.47-μf capacitor. This control adjusts the L + R amplitude in the matrix, and is set for greatest separation of the left and right channels. Coil L1 is a low-pass filter which attenuates all frequencies above 15 kc. Resistor R4 terminates this network and L1's output is fed to the matrix.

From the plate of V1-a, the composite signal is fed to V1-b, also a 12AU7 triode. The subcarrier signal is also taken off V1-a's plate at the junction of R9 and R10 and is fed through filter network L2, L3 and on to the matrix. The 19-kc pilot signal is taken off V1-b's plate and coupled to a tap on oscillator coil L4. [Note the wiring at this point. There are two possible connections here. With tuners that have a fairly high output (1 volt or more) use the connection which bypasses C14 and uses the capacitor built into the coil. However, with low-output tuners this arrangement will give you a critical and narrow locking range. If you find the locking range narrow and critical use the alternate hookup with C14 and bypass the capacitor built into the coil.] The coil, which is resonated by C11, acts as a low impedance to all frequencies other than 19 kc, and filters that frequency out effectively. Triode V2-a is the 19-kc electron-coupled oscillator and is synchronized by the pilot subcarrier fed to L4. The output of this stage is resonated at the oscillator second harmonic (38 kc) by coil L5. The plate is, in effect, tapped down the coil to provide more efficient doubling action. The 38-kc subcarrier is fed to the synchronous detector from the plate end of L5's primary. Series resistor R19 and capacitor C15 set the level of the reinserted carrier. The secondary winding shown in coil L5 is not used. In an earlier version it was hooked up, but distortion was higher.

The amplitude of the subcarrier sidebands is reduced slightly to insure that they feed the matrix with exactly the same amplitude as the main-channel information. This is done by tapping the 23- to 53-kc bandpass network down on the plate load of V1-a. Coil L2 is a series-tuned circuit that is resonant at approximately 48 kc. Note that a capacitor is connected across this series combination to provide an anti-resonant frequency. The frequency of the null in the response that results from this combination is set to 67 kc, the SCA (*s*ubsidiary *c*ommunications *a*uthorization) frequency. If this is not done, the second harmonic of the 38-kc subcarrier will beat with the 67-kc subcarrier and produce an annoying 9-kc whistle. The second coil in the bandpass network, L3, resonates around 38 kc and has a rapid attenuation curve below 23 kc. The re-

BENCH TESTED

A member of the staff of RADIO-ELECTRONICS was present when this unit was tested at an electronics laboratory. The test results showed that good separation was obtained to at least 12 kc, decreasing somewhat above this frequency. However, even at 15 kc, the highest frequency that will be transmitted during an FM stereo broadcast, separation was satisfactory. Inputs between approximately 0.4 and 2.0 volts produce a satisfactory stereo effect. The unit was also tested "in the home" with an actual FM stereo signal. Again results were satisfactory.

sponse curve produced by these two coils is relatively flat between 23 and 53 kc and separates the subcarrier sidebands from the remaining information.

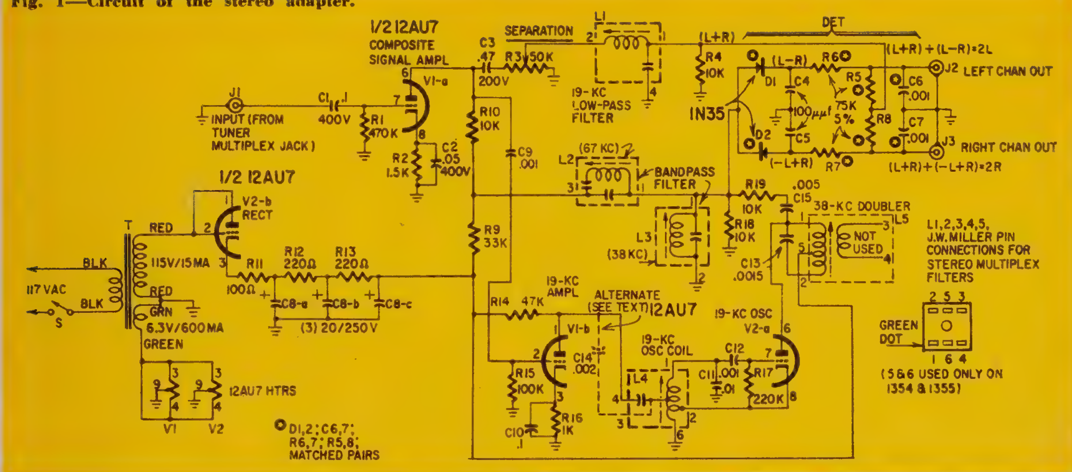
The subcarrier sidebands and the reinserted carrier feed the junction of diodes D1 and D2 connected to produce demodulated signals of opposite phase. D1 rectifies an L − R signal while D2 rectifies the − L + R half of the subcarrier. Thus the L − R signal from D1 results in L being in phase with the L + R main channel but R is out of phase. Therefore the signal at jack J2 is for the left channel. Diode D2 produces a − L + R signal. Therefore L is out of phase with the L + R main channel but R is in phase. Thus the output from J3 represents the right-channel signal.

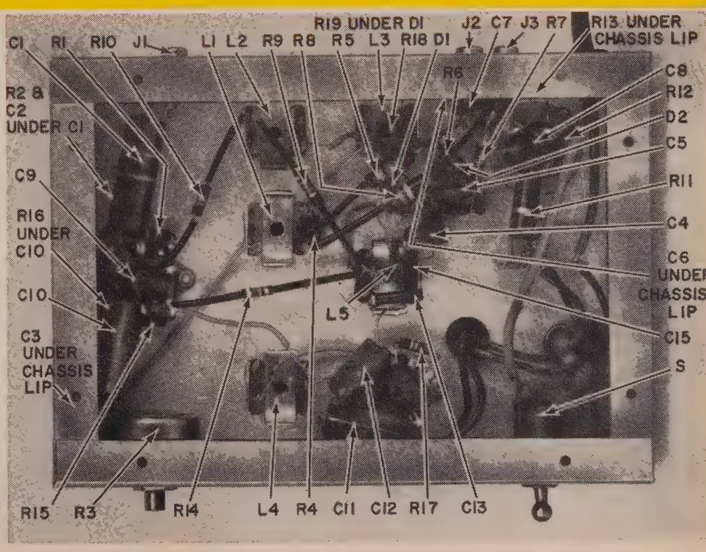
The power supply is conventional and uses the remaining 12AU7 triode as a rectifier. Although this service exceeds the heater–cathode rating slightly, dozens of hours of operation indicate that it is not harmful. A 100-ohm ½-watt resistor (R11) protects the rectifier against surges. A multi-section electrolytic insures a minimum of ripple on the B-plus line. A small 1-to-1 isolation type power transformer eliminates any shock hazard from the ac line. If desired a 100-ma silicon diode rectifier could be used here. If you do this, use a 6C4 single triode for V2. It has the same characteristics as a half of a 12AU7.

The pin connections for the filter coils are shown in Fig. 1; they are numbered clockwise from pin 1 (green dot). Pin 5 is inserted between 2 and 3, while pin 6 is on the opposite side between pins 1 and 4. The pin connections and coil numbers must be observed faithfully or it will not be possible to make the adapter work properly.

R1—470,000 ohms
R2—1,500 ohms
R3—pot, 50,000 ohms, linear taper
R4, R10, R18, R19—10,000 ohms
R5, R6, R7, R8—75,000 ohms, 5% (preferably matched, see text)
R9—33,000 ohms
R11—100 ohms
R12, R13—220 ohms
R14—47,000 ohms
R15—100,000 ohms
R16—1,000 ohms
R17—220,000 ohms
All resistors ½-watt 10% unless noted
C1—0.1 μf, 400 volts, paper
C2—.05 μf, 400 volts, paper
C3—0.47 μf, 200 volts, paper
C4, C5—100 μμf, disc ceramic
C6, C7—.001 μf, disc ceramic (preferably matched)
C8—20-20-20 μf, 250 volts, electrolytic
C9—.001 μf, disc ceramic
(Sprague TVL-3532 or equivalent)
C10—.1 μf, paper
C11—.01 μf, silver mica
C12—.001 μf, silver mica
C13—.0015 μf, silver mica
C14—.002 μf, disc ceramic
C15—.005 μf, disc ceramic
D1, D2—1N35 or similar matched diodes (see text)
J1, J2, J3—phono jacks
L1—19-kc low pass filter (Miller No. 1351)
L2—bandpass filter (Miller No. 1352)
L3—bandpass filter (Miller No. 1353)
L4—19-kc oscillator (Miller No. 1354)
L5—38-kc doubler output (Miller No. 1355)
S—spst toggle
T—power transformer: primary 117 volts; secondary, 115 volts, 15 ma; 6.3 volts, 600 ma (Triad R-54X or equivalent)
V1, V2—12AU7
Chassis, 5 x 7 x 2 inches
Miscellaneous hardware

Fig. 1—Circuit of the stereo adapter.





STONER MULTIPLEX ADAPTER

A printed-circuit board with the necessary printed-circuit tube sockets is available from Donald Stoner, Box 7388, Alta Loma, Calif., for $5 postpaid. If you have trouble getting the coils for this unit, a kit including printed-circuit board, sockets and coils is available for $16.

Careful neat wiring is vital if you want an adapter that really works.

There is one feature this adapter does not have. There is no provision for switching from the multiplex output (for stereo broadcasts) to the regular tuner output (for mono programs). Doing this takes the adapter out of the circuit when it is not in use. This prevents it from having any effect on mono programs. There are two ways of adding this feature. One is shown in Fig. 2. Here the tuner's regular outputs are connected to the tuner input on the amplifier. The multiplex output from the tuner is connected to the adapter input. And the adapter outputs are connected to the auxiliary inputs of the amplifier. Now, on mono programs you switch the amplifier input selector to TUNER and for stereo FM to AUXILIARY.

A second way of handling this problem is shown in Fig. 3. This system is necessary if your amplifier does not have a pair of auxiliary inputs. Here you need a three-pole double-throw rotary switch (Mallory 3243J), a phono jack (J4) and a length of coax cable (about 6 inches). When this circuit is installed and the switch placed in the MONO position the regular tuner output is connected to the adapter's output jacks. At the same time, B-plus is removed from the adapter. In the MX (multiplex) position B-plus is reconnected and the tuner's multiplex output is connected to the adapter input.

Building the unit

Construction details of the adapter are shown in the photographs. No part of the circuitry appeared to be critical in any of the several models built.

The coil cans are mounted by scribing the mounting hole on the chassis, drilling within the outline and filling. This is a tedious task, to say the least, and it might be better to purchase K-Tran adapter mounting plates. A printed-circuit board will also eliminate this problem.

Input and output jacks are mounted on the rear apron while the SEPARATION control and ON–OFF switch are on the front.

There are a few precautions regarding component selections. The capacitors associated with V2-a (C11, C12 and C13) must be good-quality silver micas to prevent oscillator drift, which would result in poor separation. Resistors R5, R6, R7 and R8 should be 5% units. If you have access to an accurate ohmmeter or bridge, match R5 to R8 and R6 to R7. The exact value is relatively unimportant. The diodes should also be matched. If possible obtain a ready-matched pair known as type 1N35-A. If these are not available, measure the forward resistance of several germanium diodes and select two with the closest resistance. The capacitors in the matrix are not quite so important although, if C6 and C7 are grossly mismatched, high-frequency separation will be degraded.

Final adjustments

You will need a tunable audio generator, an audio vtvm, an oscilloscope and a wide-band FM tuner to align the stereo multiplex adapter. Warm up the newly completed adapter for approximately 10 minutes, then make the voltage comparison measurements as shown in the chart. A vtvm was used to get these readings. Set the SEPARATION control for minimum separation (slider at grounded end). Connect the audio oscillator to J1 and set the generator frequency to 38 kc. Connect your scope to the junction of D1 and D2 and set the level to 0.1 volt. Adjust coil L3 for a maximum. The peak will be very broad and you may have to look closely to see it. Next move the generator to 67 kc and adjust coil L2 for a *null.*

The null will be very sharp and you should have no difficulty seeing it. Recheck L3 at 38 kc; there is some interaction. Next set the generator to 19 kc and reduce the output to .03 volt. Switch the scope from internal sweep to external input and connect the horizontal input to the audio oscillator. It is difficult to predict what you will see, but the trace will probably be a green square or rectangle, depending on the scope adjustment. Slowly adjust L4 until the pattern suddenly locks to a figure-8 trace, indicating synchronization with the 19-kc pilot and a 2-to-1 frequency ratio. Adjust L5 for maximum vertical deflection which corresponds with maximum output of the 38-kc carrier generator.

For the remaining setup steps, connect the adapter to an FM tuner. Tune

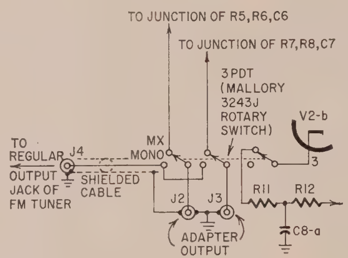


Fig. 2—Switching arrangement takes the adapter out of the circuit when it is not in use.

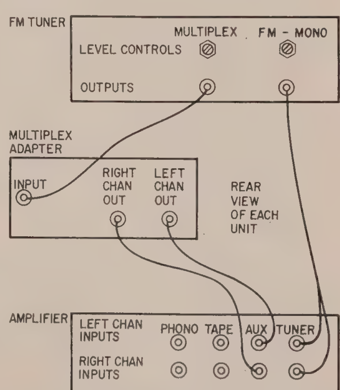


Fig. 3—Hook up your adapter in this fashion and you need only turn the selector switch on your amplifier to place it in circuit.

MULTIPLEX ADAPTER VOLTAGE CHART

no signal

	V1	V2
pin 1	50 vdc	100 vac
pin 2	0	100 vac
pin 3	1.6 vdc	124 vdc
pin 4	6.3 vac	6.3 vac
pin 5	6.3 vac	6.3 vac
pin 6	60 vdc	120 vdc
pin 7	0	neg. −8.7 vdc
pin 8	2.3 vdc	0
pin 9	ground	ground

in a station transmitting SCA (Subsidiary Communications Authorization) commercial music services. This can be determined by looking at the audio coming from the multiplex jack. It will have fuzz on the trace, indicating subcarrier components. Move the scope to the junction of D1 and D2 and make sure the separation control is still off. The fuzz on the audio should be considerably less at this point. Adjust L2 for minimum fuzz. Reason for repeating this step with a station signal is that your audio generator may not be entirely accurate.

Last, but by no means least, you need a stereo multiplex station to set L1, L4 and the SEPARATION control "on the money". Connect the adapter to two amplifiers and tune in a multiplex broadcast or test transmission. If L4 is not synchronized, you will hear a "phut-phut-phut" sound in the speakers. The speed of the motorboat indicates how far off 19-kc your generator is. Readjust L4 until the sound slows down and stops.

The remaining adjustments can be made while listening to a stereo multiplex broadcast. The stereo effect is most noticeable when listening with headphones.

Coil L1 can only be set for best separation with a stereo test signal and an oscilloscope. It is adjusted for the best null of the unwanted channel. However, in practice the adjustment is very broad and the slug can be set in the middle of the two extremes. Even when the slug is set for minimum or maximum inductance, the separation is degraded by less than 3 db.

Next, turn the separation control fully counterclockwise. In this position the main (L + R) signal is grounded out. Now the only output you will hear is the difference signal (L — R) and this will be heard only when a station transmitting a stereo multiplex signal is on the air. When a multicast is on adjust coils L4 and L5 for the clearest undistorted sound. (This will not sound normal, but you will be able to tell when it is undistorted.) At this point they are correctly set. If you find more than one coil position that gives you clear sound, use the one that gives the most volume.

Then adjust the separation controls for best separation. (This is best done when a station is broadcasting test tones.) END

INDUCTION RELAYS AND THEIR USES

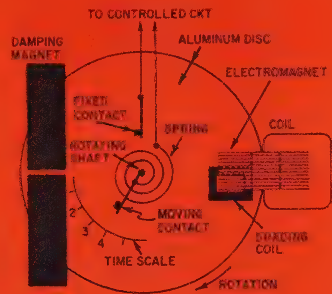


Fig. 1—The basic induction relay principle.

Fifth article in a series on relays and how they work

By TOM JASKI

In previous articles we have examined many types of relays, their circuits and applications. One important class was mentioned only briefly — induction relays. In industry, they play an important and indispensable role. Induction relays guard all large power-generating machinery, virtually all large transmission lines, large power transformers and the huge motors of the heavy industries. You will find them in steel mills, paper mills, oil refineries and chemical factories, aluminum plants and a host of other heavy industrial installations.

Fig. 1 shows the basic construction of the simplest induction relay. It consists of a rotating disc, usually aluminum, which moves between the poles of a shaded electromagnet and the poles of a permanent magnet. The forces created by the shaded magnet, being out of phase, tend to rotate the disc because of the eddy currents and resulting magnetic field generated in the disc. The permanent magnet provides damping.

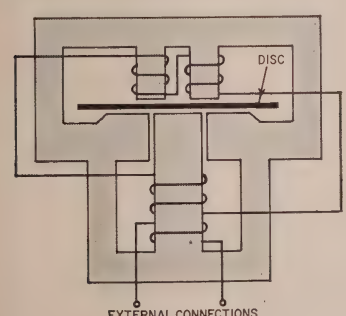


Fig. 3—Practical induction relay magnet structure.

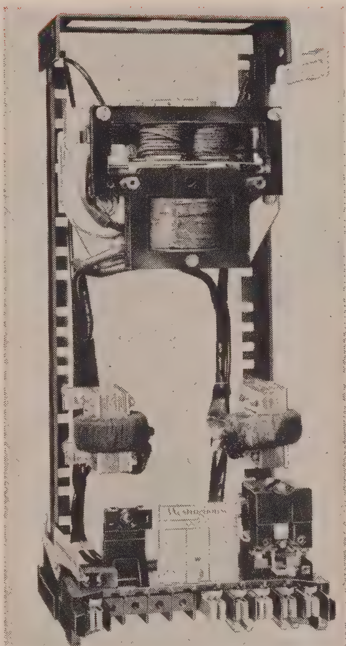


Fig. 2—A typical induction relay. Note time scale at top of relay-rotating disc.

If the disc were not restrained by a spring, it would rotate continuously, like the disc in the watthour meter in your home. In an induction relay, the disc carries the relay contacts. By controlling the amount of rotation required to make the contacts close and the rotating speed of the disc, we can accurately time the relay. We can also accurately preset the amount of current required to close the contacts. Generally, induction relays have a fixed relationship between current and time, most often an inverse time–current curve. The simple relay shown in Fig. 1 has some odd kind of time-delay curve, and actual relays are more complicated than this.

Fig. 2, a typical induction relay, is only one of many varieties. Induction relays are specially made for many functions. They can detect and act on overcurrent, overvoltage, undervoltage, over- and underfrequency, differential currents, phase faults, ground faults, asynchronism, current direction, current balance, temperature and impedance. Special forms discriminate between faults nearby and faults at a distance. It is impossible to discuss all these varieties here, so we will confine ourselves to representative types.

Induction relays may be single-, two-, or three-phase units. The type used depends on the function. If we are concerned about something which may happen in each phase separately, such as overcurrent, we use a single-phase relay. If we need a signal from two or three phases, as in directional relays which check the direction in which power or current is flowing, we use a polyphase type. On a relay panel you often see relays mounted in groups of three. This often, but not always, means

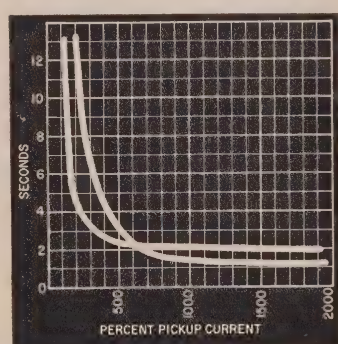


Fig. 4—Typical inverse time-current curves of induction timing relays.

that they are all single-phase relays mounted together for three phases.

In contrast to the simple diagram of Fig. 1, Fig. 3 shows the more usual form of induction-relay magnetic circuit. The main pole has two coils. One is connected to an external source. The other is in series with the coils on the upper poles. This magnetic construction provides the desirable inverse time–current curve available in this kind of relay. Fig. 4 shows some typical curves of that type. They show that, if the current applied to the relay is small, the time for closing is long; if the current is large, the relay closes fast. Of course, there is a limit beyond which no increase of speed can be obtained. This point lies near the synchronous speed—the speed at which the disc would rotate in a fully energized magnet structure and without restraints. Since the disc may rotate over quite an angle (for precision timing), it may require too much contact travel. To avoid this, the contacts are activated by a geared shaft driven by the disc. The curves in Fig. 4 are for such a geared relay.

Kinds of induction relays

The induction principle is also used in another way. If we provide any motive force, and make this rotate a disc which is restrained by a damping magnet, so that time is consumed in rotating the disc, the induction in the disc by the damping magnet delays the closing of the contacts. Such a relay is shown in Fig. 5, the Westinghouse type JD timing relay. The motive power is supplied by the clapper of a clapper type relay structure which drives the disc through a rack and pinion. Thus this relay produces a delay on both energizing and de-energizing. Note the time scale on top of the relay structure. The time is set by changing the position of the stationary contacts. Another version, the ratchet type, has a delay only on energizing.

Still another type of induction relay is shown in Fig. 6. This frequency relay can operate on either an overfrequency or underfrequency. Its structure is similar to that in Fig. 3, but it is so designed that normally there is a certain phase angle between the upper and lower poles. At 60 cycles, this phase difference is enough to provide a torque for the disc. But when the frequency changes slightly (as little as 0.1 cycle at 60 cycles), the phase angle changes and the disc drops back, opening contacts. This opening of contacts can be translated by other relays and control devices into a decreased load on the generator or a speed increase to correct the frequency difference.

The frequency of a power system is extremely important to an industrial community. If it drops by even a little, power is lost in motors. Devices (such as clocks) which depend on synchronism in the system (to run at a precise rate) lag.

Another frequently encountered relay (not an induction type) is the adjustable pickup or dropout general-purpose unit shown in Fig. 7. These are adjusted by magnetic shunts that regulate the pickup power of the coil. Where the induction timing relay can be set for delays of as much as 5 seconds (1 or even 0.5 second are more common), this relay provides a maximum delay of 0.17 second. A companion relay which looks almost exactly the same is sensitive to voltage rather than current, as far as time delay is concerned.

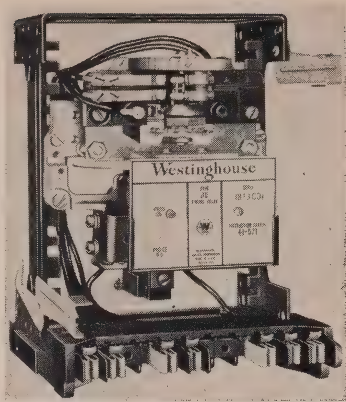


Fig. 5—This timing relay uses induction principle only for timing function. Disc is powered through clapper relay.

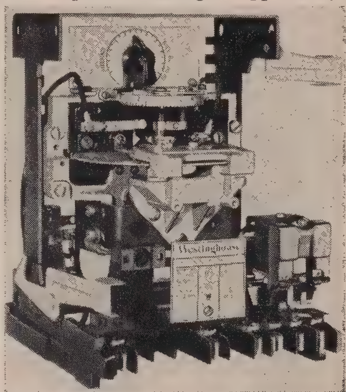


Fig. 6—Interior of frequency-sensitive relay.

Fig. 7—Common industrial relay which, though not an induction type, uses magnetic shunts to adjust pickup and dropout times.

Besides the various time-delay and special relays, there are many simple clapper type relays. Induction relays, because of their construction are necessarily limited in the number and size of their contacts and, when heavier currents must be handled, an auxiliary relay is included in the circuit.

The most common induction relay is the one whose magnet structure is shown in Fig. 3. It is a simple overcurrent relay, and you can see how it functions. If the relatively low overcurrent persists for very long, the relay contacts close. If a heavy momentary overcurrent occurs, the relay contacts close rapidly. But if the current fluctuates, with momentary but moderate overcurrents, such as might happen in a machine tool, the relay will do nothing. It is set for whatever momentary overcurrents are to be tolerated.

A relay that must operate on two or three phases has several induction magnet structures on one frame, with the required number of discs and a common shaft. But you may find a strange-looking arrangement with four rather than three magnet structures. For example, in a phase-balance relay, where information of all three phases is needed, three structures are arranged to obtain this information. Two of them are opposed on one disc on the shaft, and the third is opposed by the fourth, also on a common disc on the same shaft. The fourth magnet is inserted in either of the other two phases. It simply provides a check (balance) for the third magnet. Current-balance relays may be built in this manner, or provided with special coils or a special magnetic structure in which two coils oppose each other in terms of magnetic field.

Relays at work

Next let us see how these relays are used.

The most common relay application is the overcurrent relay. This applies to just about any electrical device, but particularly power equipment. Fig. 8 shows a simple arrangement of overcurrent relays that are set up to protect a generator against a differential current. Note first that the relay is connected through a current transformer. The current transformers used in power machinery are usually simply a single bus (half-turn) surrounded by a core which carries the secondary winding. Secondaries are almost always arranged to provide 5 amperes. *Never* leave the secondary of a current transformer open on a bus, because extremely high voltages could be induced in the windings, ruining the transformer. When not in use, keep the current transformer shorted or have some standard load on it—a resistor or sometimes a coil.

Note next that currents from these transformers are arranged in opposition, so that, if precisely the same current goes into the winding as comes out at the other end, nothing happens. But if there is a difference in the cur-

rent at the two ends of the winding, something is bound to be wrong and the relay trips. To protect the generator completely against differential faults, three such relays would be needed. Current from one current transformer obviously would protect only one phase against overcurrent.

More common for differential protection is a special differential relay. The circuit for one of these is shown in Fig. 9.

A current transformer can be used for more than one relay. A single one often supplies current to a number of relays or meters. However, for the sake of accuracy, meter current transformers are usually kept separate, and you might see several current transformers per phase. If you take a close look the next time you pass a reasonably large substation structure, you may see current transformers mounted on it.

Often current transformers alone cannot do the trick and we need information about voltage. Since power equipment almost always operates at high voltages (2,300 volts and up), special units called voltage transformers or potential transformers are needed for the voltage information. Potential transformers are practically always built to produce 120 volts. Sometimes the potential transformer is called a control transformer. This name sticks if it is used for relays only.

A normal system load is inductive to a certain extent, and the voltage leads the current. (We say the system has a power factor of less than 1.) This can easily be distinguished from a situation where the current leads the voltage. This would be a capacitive load, one that would return power rather than absorb it. In the case of a generator, this must be avoided. A relay that depends on a phase difference in its magnetic structure can easily be designed to take advantage of such a phase sensitivity, and this is done for the power-directional relays.

This situation is illustrated in Fig. 10. Here a power-directional relay is connected to a generator. Of course, it will need the appropriate current and potential transformer. Note that the potential transformer need be only a two-phase one for the three-phase situation. The transformer will produce a voltage in accordance with what happens on three phases anyway. This is called an *open-delta* connection. Note also that, since voltage and current are operating a directional relay, the proper connection of the transformers is important. A reversal of one would make the relay function oppositely.

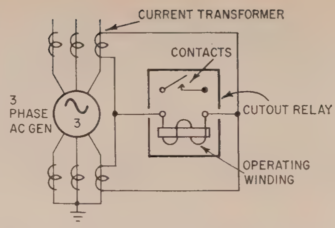


Fig. 8—Simple differential protection of one generator winding with overcurrent relay. Only one phase is shown.

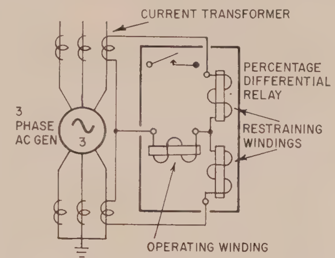


Fig. 9—Special differential relays for generator winding protection. Similar protection is provided for large motors and transformers.

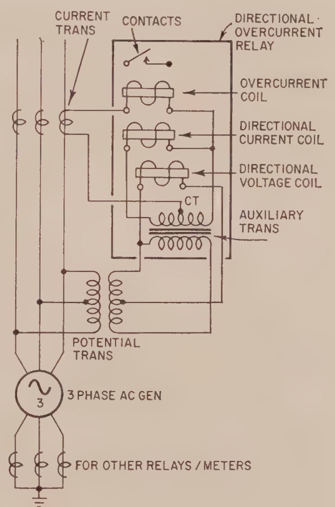


Fig. 10—Directional and overcurrent protection for a generator. Again, only one phase is shown.

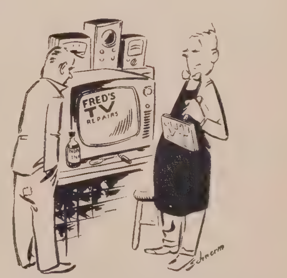
Large and important (and expensive) generators are protected against more than just overcurrent, differential and power direction. Usually such problems as frequency, over- and undervoltage, loss of field, lack of synchronism with the system, temperature rise and others are handled by relays. So are current and phase balance, grounding and other kinds of possible troubles. Transmission-line terminals, which usually consist of large power transformers or at least bus systems, are protected against faults such as phase shorts, grounds, surges and open lines. All these faults activate the relays, which then trip large circuit breakers. The circuit breakers in turn very rapidly (within 3 cycles) take a generator off the line or isolate a section of transmission line, or whatever is required to protect equipment, system and consumer.

What about electronics?

Because many of the functions required of induction relays can readily be performed electronically, one would expect electronics to have taken over a large portion of the work of induction and other protective relays. This is not so. First, induction relays are older than electronics. Second, they have been on the job for many years with complete satisfaction. In other words, they are reliable and have proven themselves thoroughly. Third, in many places it would be difficult to coordinate a new electronic relay with existing ones. Finally, most induction relays function for many years without any attention. They are virtually maintenance-free. Electronics, before the advent of the transistor, was certainly not to be trusted over many years without attention. There were always filament burnouts, etc. Now that transistors are an important factor we may see a change in the picture.

Certain functions have been entrusted to electronics in modern relays. There are now phase-comparison relays which use coincidence tubes, frequency-control relays which use tuned circuits and magnetic amplifiers, and some impedance-sensing relays. But the main stumbling block for many years has been cost. To match the accuracy and reliability of magnetic relays, electronic units would be much more expensive. The simpler the magnetic relay, the less economically feasible it is to replace it with electronics. Very complex relays may be the first ones replaced.

But there is continuous impetus for electronification. Many relays are now used with carrier systems. These may be either wire type carriers which use the power line for signal transmission, or microwave radio carriers. Increasing numbers of remote controls in the power-generating industry are being handled by microwave carrier. Naturally, if the control of large systems can be entrusted to electronic transmission, objections to reliability begin to fade drastically. Power engineers are necessarily conservative. Codes, rules, regulations and general practice in the power industry have made them so because of the heavy responsibilities to the industry they serve. Reluctance to replace something tried and true with something new and comparatively unproven is only natural. END



Uhm—Don't you think that's overdoing it just a bit?

REVERBERATION ENHANCES YOUR HI-FI AUDIO

Adds that concert-hall feeling to your records

By ROBERT F. SCOTT
TECHNICAL EDITOR

AROUND THE MIDDLE OF 1960, SEVERAL manufacturers of packaged audio equipment began featuring reverberation or controlled echo effect in some of their models. Now, a number of manufacturers are distributing reverberation units that can be added to existing audio systems.

Basically, reverberation is produced by passing a part of the program signal through a delay line and then mixing it electronically or acoustically with the undelayed signal.

Some manufacturers, musicians and hi-fi purists consider reverb units short-lived distortion-producing gimmicks. Others point out that artificial reverberation is used by all major recording studios (for pop records) and that many listeners find that adding a variable amount of reverberation enhances the overall sound. No matter which side of the question you take, these add-on reverb units and those used in RCA, Philco, Hoffman, Motorola and other hi-fi systems will have to be installed and serviced. They exist, in fair quantities, and continue to be sold in greater numbers than one might imagine.

Add-on reverberation units are of two basic types. Utah, Calbest, Heath, Lafayette and Radio Shack tap off a part of the program signal from the voice-coil terminals of the radio, phonograph or hi-fi system and use a separate amplifier and speaker to reproduce the delayed signal. They are described in this article.

The second type, which includes the CBS, Fisher, Knight and Sargent-Rayment devices, has the delay circuitry shunted across a section of the signal path in the audio system. A portion of the program signal is tapped off, passed through the delay line and then mixed with the undelayed signal in a following stage. A variable control sets the amount of delayed signal fed to the mixer to control the reverberation effect. These units will be covered in a following article.

Why add reverberation?

When listening to a recording of a favorite selection, we can't help noticing that it doesn't sound exactly like the same group performing live at Symphony Hall or in an intimate night club. We have also noticed that a group will sound different out of doors in the Hollywood Bowl, Lewisohn Stadium or at Newport from performance in a concert hall.

At a live performance we hear the original undistorted sounds "flavored" milliseconds later by multiple reflections from walls, ceiling and other surfaces at various distances from our ears. These reflections continue to bounce around the hall and back to our ears for a noticeable period after the original sound has stopped. This delayed reflection of the original sound is reverberation or echo. Variations in reverberation characteristics can cause the same performers to sound different in different locations.

The amount of reverberation we hear depends on the volume level of the original sound and on the hall acoustics. The duration of the reverberation is the time it takes to drop below the noise level or threshold of hearing. If a particular passage or note is loud, it takes longer for the reverberation to die away than when it is played at a lower level. Thus, a concert hall with acoustics best suited for band performances might be unsatisfactory for chamber-music groups that usually play softly.

Reverberation gives dimension to sounds that we hear and enables us to visualize the size of a room, even when blindfolded. For years, performers and recording engineers have known that a certain amount of reverberation enhances a performance or recording. When a recording is made in a location with little or no reverberation, they have added artificial reverberation to enhance the reproduction.

Whether or not a recording sounds like the original depends largely on the acoustics of your listening area. If the room is small and sound is absorbed by drapes, rugs and furniture, you may need the additional controlled reverberation available from these new units to give you concert-hall realism.

How reverberation units work

To provide reverberation we must

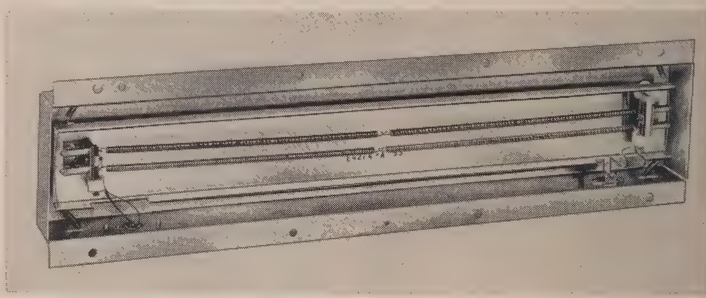
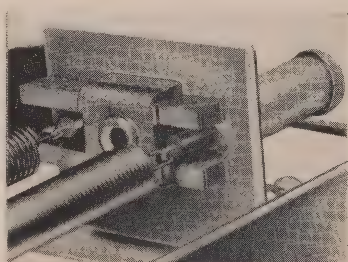


Fig. 1-a—Inside view of basic reverb unit developed by Hammond Organ.



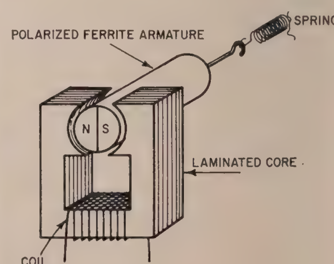


Fig. 1-b—A closeup view of input transducer.
Fig. 1-c—Rotor detail. It turns like a D'Arsonval meter armature.

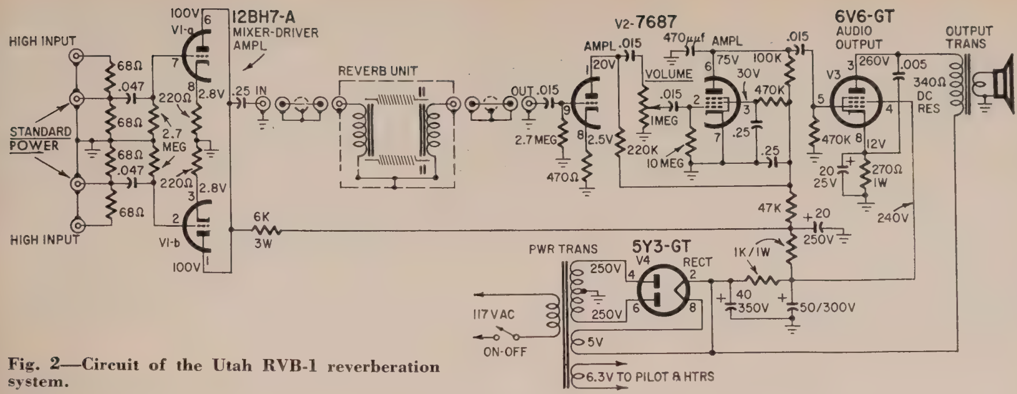


Fig. 2—Circuit of the Utah RVB-1 reverberation system.

delay, in varying amounts, some of the sound reaching the ear. In the units to be described, a coil spring is used as the delay line. A driving transducer, fed with a portion of the audio signal, vibrates the spring at one end. This signal travels down the spring to a pickup and is reflected to the other end of the spring. It then dances back and forth, decaying as it goes, between the ends of the spring, producing delayed complex electrical images of the original sounds in the output of the pickup. The stronger the driving signal, the longer the spring vibrates and the longer the overall delay.

Signals from the pickup are reproduced in a separate amplifier and speaker system or fed back into the existing audio system to be reproduced as reverberation along with the original sounds. Reverberation is most effective at mid-range frequencies so electronic circuits immediately before and after the delay line have response limited to the approximate range of 200 to 4,000 cycles.

Two basic types of delay lines are being used. One is made by Hammond Organ Co. and the other by CBS Electronics. The Hammond reverberation device is used in all reverb units except the CBS. It consists of two coil-spring delay lines designed for delays of approximately 28 and 37 milliseconds. Each delay line consists of two springs wound in opposite directions and joined together at the center (Fig. 1-a). (Winding the springs in opposite directions minimizes the effects of external vibrations and reduces the tendency to unwind over a period of time.)

The ends of the delay lines are fastened to rotors of torsional type electromagnetic transducers (Fig. 1-b). The ferrite cores are magnetized crosswise so they twist in the varying magnetic field developed by the driving coil. The transducer at one end is the driver, and the other is the pickup. The signal fed to the driver coil causes the rotor to twist back and forth like the armature of a D'Arsonval meter (Fig. 1-c). The direction and amplitude of the rotor's motion are in proportion to the direction and amplitude of the signal in the coil.

The twist applied by the driver's rotor travels down the spring to the pickup rotor, which induces a delayed replica of the driver voltage in the pickup coil. This process is repeated a number of times for each initial signal fed to the driver. Thus, when the pickup's output is reproduced, the result is a complex of signals of different time delays and amplitudes that simulates the acoustics of a concert hall.

Speaker type add-on units

Fig. 2 is the schematic of the Utah RVB-1 reverberation system. The Lafayette SK-204 and Radio Shack (catalog No. K31CX543) are similar in circuitry and appearance. The inputs to the reverberation amplifier are connected across the speaker terminals in the existing audio system. The STANDARD POWER inputs are used for stereo amplifiers delivering up to 30 watts per channel. The HIGH INPUT jacks are for amplifiers with more than 30 watts per channel.

In a monaural system, either the right or left input cable is connected across the voice-coil terminals. The input signal is amplified and fed to the driver transducer of a Hammond reverberation unit. The output of the delay line is passed through a three-stage 7687-6V6-GT amplifier to a built-in speaker.

When the RVB-1 is used with a stereo system, the input terminals are bridged across the right- and left-channel speaker terminals. The signals are mixed in the common plate circuits of the 12BH7-A. From there on, the signal is delayed and reproduced as in a monaural setup. The reverberation speaker acts as a phantom center channel in a stereo installation.

The RVB-1 reverberation amplifier and 8-inch PM speaker are in a 10 x 20 x 10-3/16-inch finished bookshelf type enclosure. Power output is 3 watts. The RVB-1 comes with two 15-foot cables with phono plugs on one end and stripped and tinned at the other.

A transistor unit

The Calbest 603-T Reverb-O-Plex reverberation unit is transistorized as shown in Fig. 3. Signals from the speakers in a stereo system are fed through 100-ohm decoupling resistors and mixed (A + B) in the 2,500-ohm REVERB CONTROL. The signal is then delayed and fed through a three-stage amplifier to the built-in speaker.

Ordinary monaural radios and amplifiers with 3-ohm speakers may not pro-

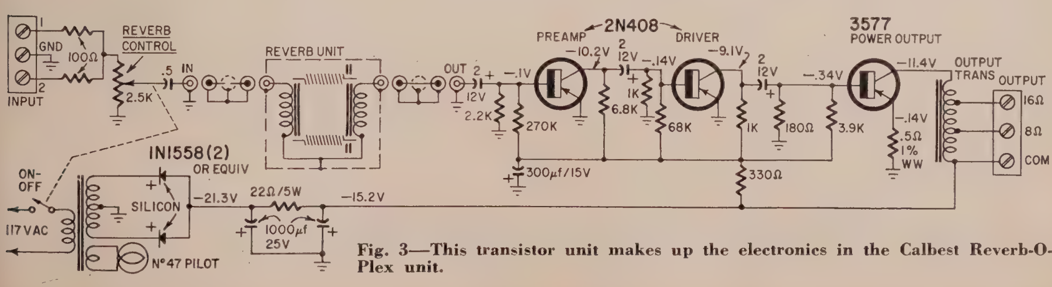


Fig. 3—This transistor unit makes up the electronics in the Calbest Reverb-O-Plex unit.

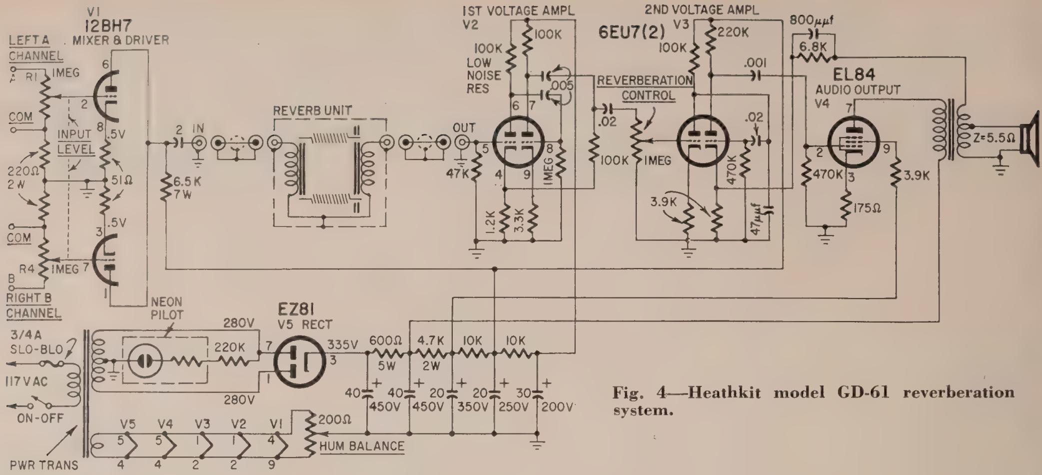


Fig. 4—Heathkit model GD-61 reverberation system.

vide enough drive voltage for these add-on systems, so the right and left input circuits must be paralleled across a 3-ohm speaker system.

Heath GD-61

This reverberation system (Fig. 4) is similar in circuitry and operation to the Utah system. Extra features are two more stages of voltage amplification and an input level control. Its frequency response is 3 db from 200 to 4,000 cycles with less than 2% harmonic distortion at 3 watts output. It requires a 250-mv input for a 3-watt output. Reverberation decay time is approximately 2 seconds at 300 cycles. The GD-61 is supplied completely assembled and wired with amplifier, Hammond delay line and 8-inch mid-range speaker in 11½ x 23 x 11¾-inch bookshelf type enclosure.

In a stereo installation, leads from the left-channel speaker are connected across R1 (between terminals A and COM) and the leads from the right-channel speaker connect across terminals B and COM. The signals to terminals A and B must be in phase for proper operation of the system. For mono, terminals A and B are strapped together and signal leads connected to A and either of the two COM terminals. END

By **FRED SHUNAMAN**
MANAGING EDITOR

NEW THOUGHT IN SERVICE BENCHES

Your Managing Editor inspects the setup on the third bench (foreground). At fourth bench is Peter Mumola, son of proprietor and head of a local short-wave club; behind him Ernest Mumola, and, at the rear, veteran radio repairman Chris De Loura.

THE SERVICE BENCH IS THE TECHNICIAN'S most important piece of equipment. As such, it has become pretty well standardized, and service benches differ very little from one end of the country to the other. Service bench design has apparently come pretty close to perfection.

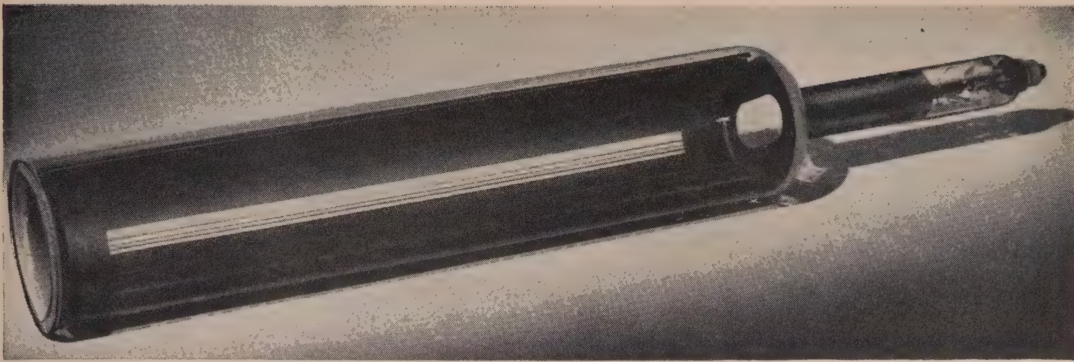
This opinion is not shared by Ernest Mumola, proprietor of Manhattan Television Co. of New York City. His bench is not, in fact, a bench at all, but a series of nine, individual benches, set end-on to the wall. Each small bench is 2 feet wide and extends 4 feet out from the wall, large enough to accommodate the largest TV chassis.

Each of the small benches has its own outlets, and a convenient number of them are supplied with tools. The larger service instruments are shared by all benches, and are kept on the shelf that runs along the wall.

One advantage of this setup will jump out at every technician. When it is necessary to postpone work on a set for any reason, it can be left right where it is and the technician can work on the next set on another bench. Test equipment can be left clipped into the circuit if it is not needed elsewhere.

Other advantages are not so obvious but none the less real. The technician is not interfered with by the man in the next working position. There is a certain privacy that helps concentration and makes for better work. There is less danger, if the technician steps back from the bench, of colliding with someone carrying a chassis down the aisle. Since each technician is facing front, a customer is seen entering the store immediately, even though there may be only one man in the shop.

This "bench" appears unique, but may not be the only one of its kind. There may even be other unorthodox and efficient variations in service benches (or other features of shop equipment, technique or management) that might give the alert technician some useful ideas. If you know of any, tell us about them. RADIO-ELECTRONICS will pay good rates for usable articles or short descriptions. END



BANANA TUBE IS COLOR CRT

New picture tube for color TV combines mechanical and optical scanning systems

By ERIC LESLIE

A NEW TYPE OF COLOR TV TUBE HAS BEEN developed by scientists of the British Mullard Co., in cooperation with Dutch Philips. It combines a number of features that have been used in widely different types of television display devices. Although cylindrical instead of flat, it has the gun mounted parallel with the "face" of the tube (if this tube can be said to have a face) and bends the beam to strike the phosphor at the desired point. It uses the "virtual image" principle introduced in the Philco battery TV (RADIO-ELECTRONICS, August, 1960). It goes far back historically in two important details—it uses *mechanical* scanning in the vertical sweep, and it uses optical lenses, which go back to the de Forest TV sets of the early '30's.

The new tube is called the "banana," partly to follow the tradition of the Philco "apple" and partly because of its shape. The gun is mounted at one end and a special yoke or "bowing magnet" produces the horizontal sweep (Fig. 1). The screen is a narrow strip ¼ inch wide and 16 inches long, composed of three color stripes, as shown in Fig. 2. The beam is wobbled up and down, as in the Lawrence tube, for the desired color.

From here, the action is different from that of any previous color tube. The device becomes a special kind of projection tube. Light from the phosphors strikes a rod like cylindrical lens mounted on a drum which runs the length of the tube, and is projected against a mirror shaped to correct picture distortion caused by the screen and lens system, and to produce a virtual image that appears to be some distance behind the mirror, and therefore larger (Fig. 3). The tube is lightproof except for the cylindrical lenses. Thus the projection is not diluted by other light on the mirror, as would be the case if the beam were projected on a light screen.

Three lenses are used. When the first reaches the bottom of the screen, the second starts to scan from the top. The lenses are mounted on a drum that encircles the tube and turns at about 1,000 rpm for the standard British 50 fields per second. The drum is governed by a control not unlike the afc in ordinary TV sync systems.

The tube uses quite a bit of power—3 ma at 25 kv. That is the reason for the heat-dissipating films shown in Fig. 3. Brightness of 40 foot-lamberts is claimed.

The research team that developed the tube is careful to point out that it is still a long way from commercialization, and that work will still have to be done on it before it can be determined whether it will be a serious rival of other color TV tubes. END

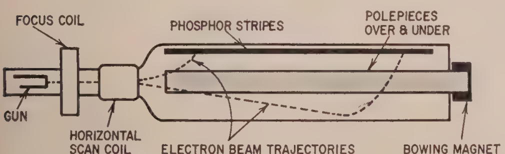


Fig. 1—Basic diagram of the tube. Spot-wobble coils, not shown, direct the beam to the proper phosphor.

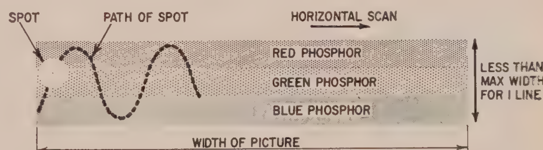


Fig. 2—Color phosphor layout. Total stripe width is about ¼ inch wide and 16 inches long.

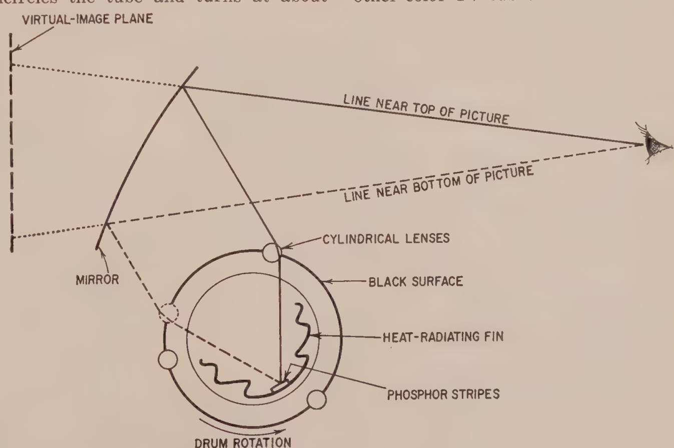


Fig. 3—End view shows rotating drum that surrounds the tube. This drum carries three lenses.

TRANSISTOR ROUNDUP

By JAMES R. SPENCER

HAVE YOU THOUGHT OF ENTERING THE challenging field of transistor circuitry, only to be discouraged by the thousands of types on the market today? Have you scanned the ads and sorted through stacks of manufacturers' spec sheets looking for just the right low-cost transistor for your circuit? Are transistors available that can give you needed watts of audio power? Are high-frequency transistors all high-priced? If these are your problems, "Transistor Roundup" will help you find the right transistor, at the right price.

The directory distills over 2,000 manufacturers' transistor specification sheets into a listing of about 500 readily available low-cost transistors. Availability was the first consideration in compiling the list. All the transistors listed are in stock at most large electronics parts stores or can be ordered from large electronic parts mail-order houses. Price was the second consideration. Only transistors costing $5 or less are included. Bound by these two limitations, each transistor included was selected to provide the widest possible range of types, operating characteristics and case styles. Audio-frequency transistors included range from the microminiature low-noise hearing-aid amplifier 2N207 to the massive 2N1554 power amplifier. For radio-frequency applications, transistors are listed which operate from 455 kc (2N94) to 250 mc (2N588). For industrial control applications, a wide range of switching transistors has been included.

Type No.—Transistors are listed numerically according to their Electronic Industries Association (EIA) registration number. For some type numbers, A and B types are indicated as also being available. They usually have more closely controlled electrical characteristics and are generally more expensive than the price indicated in the third column. A "†" following the type number indicates the transistor is considered obsolete and not recommended for new equipment design.

Mfr.—The manufacturers are coded numerically according to the following list. Where more than one manufacturer is given for a particular type number, the first one listed is known to offer the specific transistor in the price range indicated in the next column. The remaining manufacturers may or may not offer it at the same price.

Code Number	Manufacturer
1	Bendix Aviation Corp.
2	CBS Electronics
3	Clevite Transistor Products
4	Delco Radio Div., GMC
5	General Electric Co.
6	General Transistor Corp.
7	Industro Transistor Corp.
8	Motorola Inc.
9	Philco Corp.
10	Radio Corp. of America
11	Raytheon Co.
12	Sprague Electric Co.
13	Sylvania Electric Products, Inc.
14	Tung-Sol Electric Co.
15	Texas Instruments Inc.

Price—Because of regional and other variances, exact price is not quoted; the type number is indicated in one of three price ranges: *under 1, **from $1.01 to $2.50 and ***from $2.51 to $5.

Type—To indicate biasing requirements, the type, n-p-n, or p-n-p, is given. N-p-n transistors require negative bias on the emitter and positive bias on the collector with respect to the base. P-n-p transistors require positive bias on the emitter, negative bias on collector.

Typical Application—This column should be self-explanatory. Typical uses such as af amplifier, oscillator, driver, rf converter, mixer, if amplifier and many others are suggested.

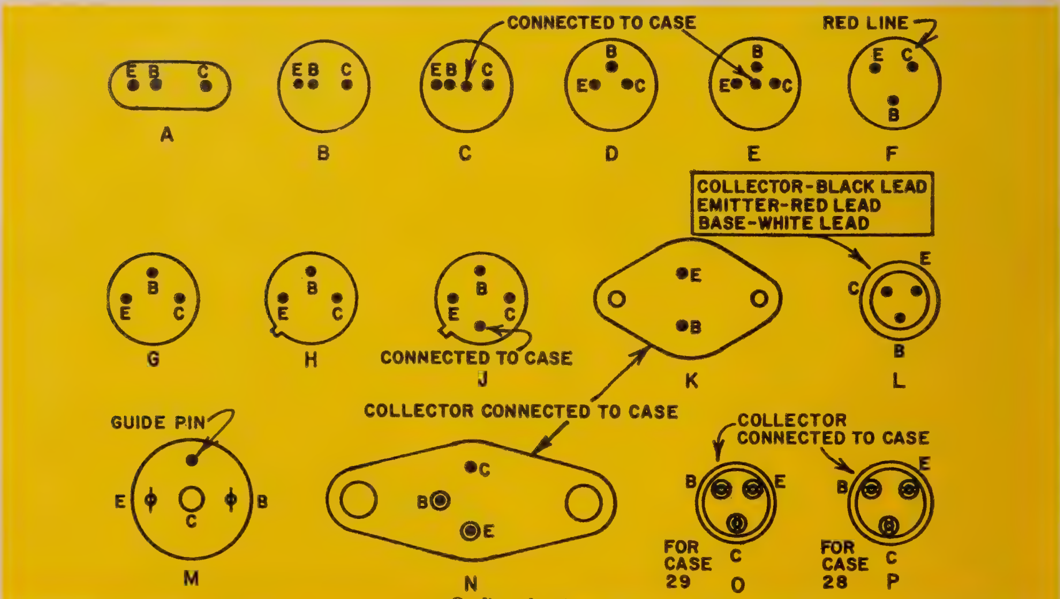
Case—The numbers in this column refer to the transistor case silhouettes which are shown about actual size.

Base—The letters in this column refer to the basing diagrams. Many manufacturers connect one or another of the leads to the case structure, so the individual transistor specification sheet should be referred to before connecting the transistor into a circuit, especially for base diagrams B, G and H.

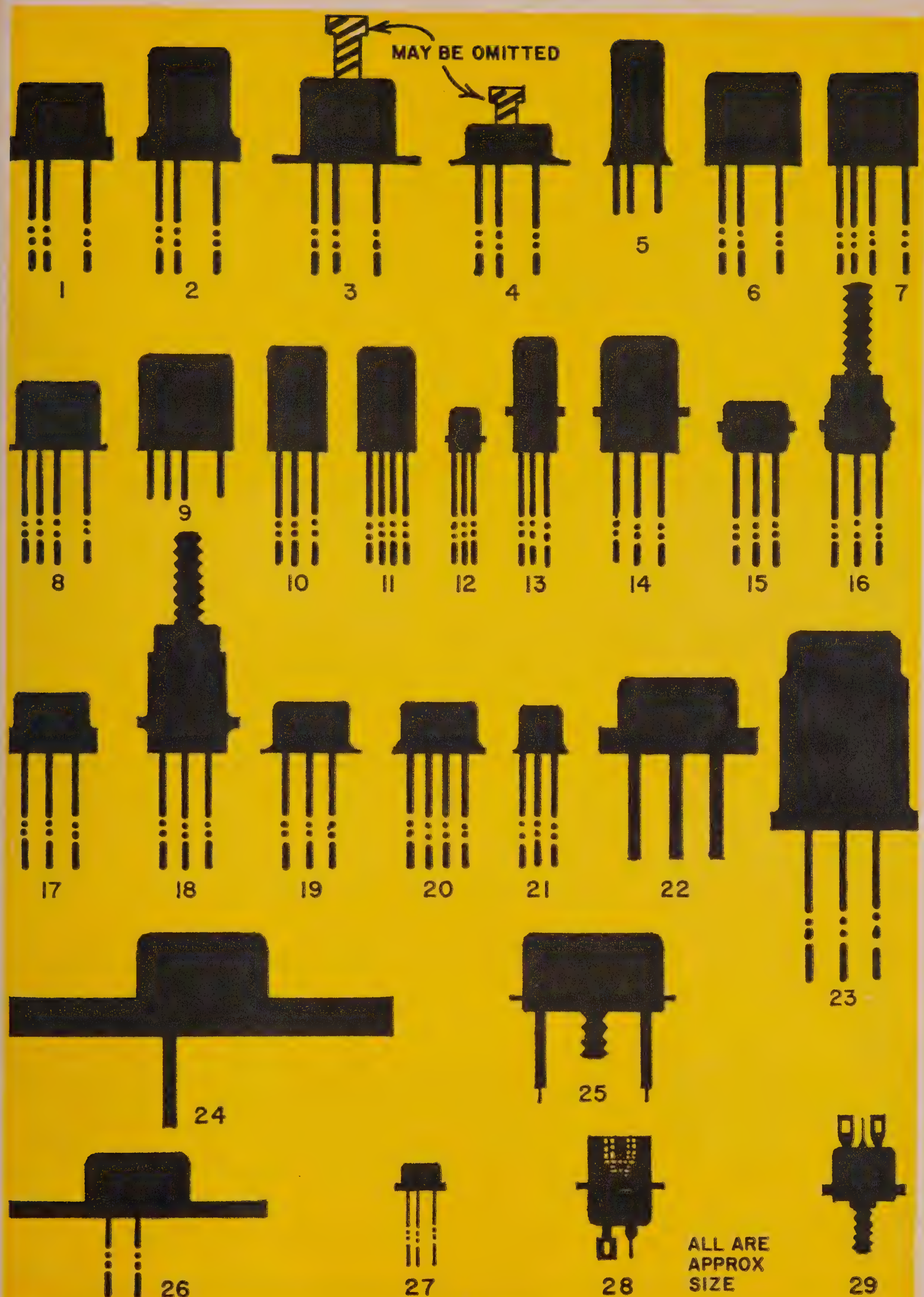
Max Ratings—Three pertinent maximum ratings are given for each transistor: V_{CB}, the maximum collector-to-base dc voltage in volts; I_C, the maximum dc collector current in milliamps, or amps where noted; and the maximum collector dissipation in milliwatts, or watts where noted. These maximum ratings are absolute values which, if exceeded, will cause permanent damage to the transistor.

h_{fe} or h_{FE}—h_{fe} is the small-signal ac forward-current transfer ratio. h_{FE} is the dc forward-current transfer ratio. In more common terms, they represent ac or dc gain. Typical values are given wherever possible.

Alpha Cutoff Frequency—This is the frequency at which alpha (short-circuit emitter-to-collector current gain) is 0.707 of its low-frequency value.



Outline drawings.



Basing diagrams.

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	MAX RATINGS I_C ma	MAX RATINGS Collector Dissipation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N34	13	***	p-n-p	af (ampl/osc/driver)	2	A	−40	100	150	40	10 kc
2N35	13	**	n-p-n	af (ampl/osc/driver)	2	A	40	100	150	40	10 kc
2N43, A	5, 6	***	p-n-p	af (ampl/osc/driver)	4	B	−45	300	240	65	1.3 mc
2N44, A	5, 6	***	p-n-p	af (ampl/osc/driver)	4	B	−45	300	240	43	1.3 mc
2N45†	5, 6	***	p-n-p	af (ampl/osc/driver)	4	B	−25	10	155	25	500 kc
2N78	5	***	n-p-n	rf (540–1640-kc ampl) if (455-kc ampl)	3	A	15	20	65	135	9 mc
2N94	13	**	n-p-n	if (455 kc ampl)	2	A	20	50	50	80	2 mc
2N94-A	13	***	n-p-n	if (455 kc ampl)	2	A	20	50	50	80	5 mc
2N102/113	2	***	n-p-n	af (power ampl)	28	P	30	1 A	20 W	55	
2N104	10	**	p-n-p	af (ampl/osc/driver)	5	B	−30	50	150	44	700 kc
2N107	5	*	p-n-p	af (small-signal ampl)	4	B	−10	100	50	20	1 mc
2N109	10,13	**	p-n-p	af (ampl/osc/driver)	5	B	−25	75	50	75	
2N123	5, 13	**	p-n-p	high freq switch	4	B	−20	125	150	65	8 mc
2N135	5	**	p-n-p	rf (540-1640-kc ampl) if (455-kc ampl)	4	B	−20	50	100	20	4.5 mc
2N136	5	***	p-n-p	rf (540–1640-kc ampl) 'f (455-kc ampl)	4	B	−20	50	100	40	6.5 mc
2N139	10,13	**	p-n-p	if (455-kc ampl)	5	B	−16	15	35	65	850 kc
2N140	10,13	**	p-n-p	rf (540–1640-kc converter/mixer)	5	B	−16	15	35	48	7 mc
2N144/13	2	***	n-p-n	af (power ampl)	28	P	60	1 A	20 W	55	
2N155	2,1,3, 11,13	***	p-n-p	af (power ampl)	24	K	−30	3 A	8.5 W	45	180 kc
2N156	2	***	p-n-p	af (power ampl)	23	L	−30	3 A	8.5 W	45	180 kc
2N157, A	2	***	p-n-p	af (power ampl)	24	K	−60	3 A	20 W	60	180 kc
2N158, A	2	***	p-n-p	af (power ampl)	23	L	−60	3 A	20 W	50	4 kc
2N168-A	13, 5	**	n-p-n-	rf (540-1640-kc osc)	3	A	15	20	65	100	8 mc
2N169, A	5, 13	**	n-p-n	if (455-kc ampl)	3	A	15	20	65	72	4 mc
2N170	5	**	n-p-n	'f (455-kc amp)	3	A		20	25	32	5 mc
2N173	2	***	p-n-p	af (power ampl)	25	M	−60		70 W	70	
2N174	2	***	p-n-p	af (power ampl)	25	M	−60		85 W	50	
2N175	10,13	**	p-n-p	af ('ow-noise ampl)	5	B	−10	2	20	65	850 kc
2N176	8, 1, 10,13	**	p-n-p	af (power ampl)	24	K	−40	3 A	10 W	90	5 kc
2N178	8	**	p-n-p	af (power ampl)	24	K	−30	3 A	90 W	30	5 mc
2N185	15	*	p-n-p	af (ampl/osc/driver)	1	A	−20	150	150	55	800 kc
2N186, A	5	**	p-n-p	af (ampl/osc)	4	B	−25	200	75	24	1.8 mc
2N187-A	5	**	p-n-p	af (ampl/osc/driver)	4	B	−25	200	200	36	1 mc
2N188-A	5	**	p-n-p	af (ampl/osc/driver)	4	B	−25	200	200	54	1.2 mc
2N189	5	**	p-n-p	af (ampl/osc)	4	B	−25	50	75	32	800 kc
2N190	5	**	p-n-p	af (ampl/osc)	4	B	−25	50	75	42	1 mc
2N191	5	**	p-n-p	af (ampl/osc)	4	B	−25	50	75	67	1.2 mc
2N192	5	**	p-n-p	af (ampl/osc)	4	B	−25	50	75	90	1.5 mc
2N193	13	**	n-p-n	rf (540–1640-kc osc/converter)	2	A		50	50	15	3.5 mc
2N194, A	13	**	n-p-n	rf (540–1640-kc converter)	2	A		50	50	15	3.5 mc
2N207, A	9	**	p-n-p	af (low-noise ampl—hearing aid)	12	F	−12	20	50	100	2 mc
2N207-B	9	**	p-n-p	af (low-noise ampl—hearing aid)	12	F	−12	20	50	100	2 mc
2N212	13	**	n-p-n	rf (540-1640-kc converter)	2	A		50	50	30	4 mc
2N213, A	13	**	n-p-n	af (ampl/osc/driver)	2	A	40	100	150	250	10 kc
2N214	13	**	n-p-n	af (ampl/osc/driver)	2	A	40	100	180	100	10 kc
2N215	10	**	p-n-p	af (ampl/osc/driver)	10	D	−30	50	150	44	700 kc
2N216	13	**	n-p-n	if (455-kc ampl)	2	A			50	7.5	3 mc
2N217	13,10	**	p-n-p	af (ampl/osc/driver)	2	A	−25	70	150	150	400 kc
2N218	10	**	p-n-p	rf (540-1640-kc osc) if (455-kc ampl)	10	D	−16	15	35	48	4.7 mc
2N219	10	**	p-n-p	rf (540–1640-kc converter/mixer)	10	D	−16	15	35	48	7 mc
2N220	10	**	p-n-p	af (ampl/osc)	10	D	−10	2	20	65	850 kc
2N223	9	**	p-n-p	af (ampl/osc/driver)	14	F	−18	150	250	110	600 kc
2N224	9	**	p-n-p	af (ampl/osc/driver)	14	F	−25	150	250	90	510 kc
2N225	9	**	p-n-p	af (ampl/osc/driver)	14	F	−25	150	250	90	510 kc
2N226	9	**	p-n-p	af (ampl/osc/driver)	14	F	−30	150	250	60	400 kc
2N227	9	**	p-n-p	af (ampl/osc/driver)	14	F	−30	150	250	60	400 kc
2N228	13	**	n-p-n	af (ampl/osc/driver)	2	A	40	100	50	100	10 kc
2N229	13	*	n-p-n	af (ampl/osc/driver)	2	A			50	25	600 kc
2N232	9	**	p-n-p	rf (540-kc–20-mc ampl)	13	F	−4.5	3	9	39	f_{max} 20 mc
2N233, A	13	*	n-p-n	if (455-kc ampl)	2	A	10	50	50	15	

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	MAX RATINGS I_C ma	MAX RATINGS Collector Dissipation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N235-B	13, 1, 2, 3	**	p-n-p	af (power ampl)	24	K	−40	3 A	25 W	30	400 kc#
2N236, A	2	***	p-n-p	af (power ampl)	24	K	−50	3 A	25 W	35	6 kc
2N238	15	*	p-n-p	af (ampl/osc/driver)	1	A	−20	150	150	50	
2N241-A	5, 13	**	p-n-p	af (ampl/osc/driver)	4	B	−25	200	200	100	1.3 mc
2N242	13,1,2, 3, 14	**	p-n-p	af (power ampl)	24	K	−45	2 A	50 W	50	400 kc
2N248	15	***	p-n-p	rf (high freq ampl/osc/mixer)	1	A	−25	5	30	20	50 mc
2N250	15, 3	***	p-n-p	af (power ampl)	24	K	−30	7 A	25 W	30	6 kc#
2N251	15	***	p-n-p-	af (power ampl)	24	K	−60	7 A	25 W	30	6 kc
2N252	15	***	p-n-p	rf (540–1640-kc converter)	1	A	−16	5	30		
2N253	15	**	n-p-n	if (455-kc ampl)	1	A		5	65	32	
2N254	15	***	n-p-n	if (455-kc ampl)	1	A		5	65	36	
2N255	13, 1, 3	**	p-n-p	af (power ampl)	24	K	−15	3 A	1.5 W	50	200 kc
2N256	13, 1, 3	**	p-n-p	af (power ampl)	24	K	−30	3 A	1.5 W	50	200 kc
2N257	13, 1, 2, 3	**	p-n-p	af (power ampl)	24	K	−40	5 A	4 W	50	7 kc#
2N265	5	**	p-n-p	af (ampl/osc)	4	B	−25	50	75	115	1.5 mc
2N269	10	***	p-n-p	low-level switch	10	D	−20	100	35	35	4 mc
2N270	10, 13	**	p-n-p	af (ampl/osc/driver)	6	B	−25	150	150	70	
2N274	10	**	p-n-p	rf (1.5–12.5-mc ampl)	11	E	−35	10	80	60	30 mc
2N277	15, 4, 8, 2	***	p-n-p	af (power ampl)	25	M	−40	15 A	150 W	50	
2N278	8, 2	***	p-n-p	af (high-gain power ampl)			−50	15 A	150 W	35-70	
2N285-A	13, 1,	**	p-n-p	af (power ampl)	24	K	−40	3 A	25 W	35	400 kc
2N291	15	**	p-n-p	af (ampl/osc/driver)	2	A	−25	200	300	45	
2N292	13, 5	*	n-p-n	if (455-kc ampl)	3	A	15	20	65	25	5 mc
2N293	5	**	n-p-n	if (455-kc ampl)	3	A	15	20	65	25	8 mc
2N297-A	8,1,2, 3, 4	***	p-n-p	af (power ampl)	24	K	−60	4 A	10 W	70	5 kc#
2N301, A	10, 1, 2, 3, 13	**	p-n-p	af (power ampl)	24	K	−30	3 A	11 W	70	400 kc
2N306	13, 2	*	n-p-n	af (ampl/osc)	2	A	20	100	50	60	600 kc
2N307, A	13, 1, 10, 14	**	p-n-p	af (power ampl)	24	K	−35	2 A	10 W	21	400 kc
2N308	15	***	p-n-p	if (455-kc ampl)	1	A	−20	5	30	40	
2N309	15	***	p-n-p	if (455-kc ampl)	1	A	−20	5	30	42	
2N312	2	***	n-p-n	af (switch)	19	G	15		180	75	30 kc
2N319	5	**	p-n-p	af (ampl/osc/driver)	19	H	−30	200	225	34	2 mc
2N320	5	**	p-n-p	af (ampl/osc/driver)	19	H	−30	200	225	50	2.5 mc
2N321	5, 13	**	p-n-p	af (ampl/osc/driver)	19	H	−30	200	225	80	3.1 mc
2N322	5	**	p-n-p	af (ampl/osc/driver)	19	H	−16	100	140	50	2 mc
2N323	5	*	p-n-p	af (ampl/osc/driver)	19	H	−16	100	140	75	2.5 mc
2N324	5	**	p-n-p	af (ampl/osc/driver)	19	H	−16	100	140	95	3 mc
2N326	2	***	n-p-n	af (power ampl)	24	K	35	2 A	7 W	60	180 kc
2N331	8, 1, 6, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−30	200	200	70	400 kc
2N344	9, 12	***	p-n-p	rf (high freq ampl/osc/conv/mix)	13	F	−5	5	20	22	f_{max} 50 mc
2N345	9, 12	***	p-n-p	rf (high freq ampl/osc/conv/mix)	13	F	−5	5	20	35	f_{max} 50 mc
2N350, A	8	**	p-n-p	af (power ampl)	24	K	−50	3 A	90 W	30	5 kc
2N351-A	8	**	p-n-p	af (power ampl)	24	K	−50	4 A	90 W	45	5 kc
2N356, A	13, 2, 6	***	n-p-n	medium-freq switch	19	H	20	500	100	50	3 mc
2N357, A	13, 2, 6	***	n-p-n	medium-freq switch	19	H	20	500	100	50	6 mc
2N358-A	13, 2	***	n-p-n	medium-freq switch	19	H	20	500	100	50	9 mc
2N359	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−20	400	150	150	1.5 mc
2N360	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−20	400	150	100	1.2 mc
2N361	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−30	400	150	75	1 mc
2N362	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−20	100	150	100	
2N363	11, 7	*	p-n-p	af (ampl/osc/driver)	19	H	−40	100	150	50	
2N364	15	***	n-p-n	af (ampl/osc/driver)	1	A	30	50	150	19	2.5 mc
2N367	15	**	p-n-p	af (ampl/osc/driver)	1	A	−30	50	150		7 kc

#Beta frequency cutoff.

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	I_C ma	Collector Dissi-pation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N368	15	**	p-n-p	af (ampl/osc/driver)	1	A	−30	50	150	35	1 mc
2N369	15	**	p-n-p	af (ampl/osc/driver)	1	A	−30	50	150	90	1.3 mc
2N370	10, 13	**	p-n-p	rf (20-mc ampl)	7	C	−24	10	80	60	30 mc
2N371	10, 13	**	p-n-p	rf (20-mc osc)	7	C	−24	10	80	60	30 mc
2N372	10, 13	**	p-n-p	rf (20-mc mixer)	7	C	−24	10	80	60	30 mc
2N373†	10, 13	**	p-n-p	if (455-kc ampl)	7	C	−24	10	80	60	30 mc
2N374†	10, 13	**	p-n-p	rf (high-freq converter)	7	C	−24	10	80	60	30 mc
2N375	8, 3	***	p-n-p	af (power ampl)	24	K	−80	3 A	90 W	90	7 kc
2N376-A	8	**	p-n-p	af (power ampl)	24	K	−50	3 A	90 W	60	5 kc
2N377, A	13, 2	**	n-p-n	medium-freq switch	19	H	25	200	150	40	
2N378	14	***	p-n-p	low-speed switch (high power)	24	K	−40	5 A	50 W	30	5 kc
2N379	14	***	p-n-p	low-speed switch (high power)	24	K	−80	5 A	50 W	50	5 kc
2N381	13, 14	*	p-n-p	af (ampl/osc/driver)	19	H	−25	200	200	45	10 kc
2N382	13, 14	**	p-n-p	af (ampl/osc/driver)	19	H	−25	200	200	76	10 kc
2N383	13, 14	***	p-n-p	af (ampl/osc/driver)	19	H	−25	200	200	55	10 kc
2N384	10, 13	***	p-n-p	rf (30-mc ampl/osc/conv/mix/switch)	11	E	−40	10	120	60	100 mc
2N385, A	13, 2, 5	**	n-p-n	med-freq switch	19	H	25	200	150	60	4 mc
2N388, A	13, 2, 5, 6	***	n-p-n	med-freq switch	19	H	25	200	150	120	
2N392	4	***	p-n-p	af (power ampl)	24	K	−60	5 A		120	
2N394	5	**	p-n-p	high-freq switch	19	H	−30	200	150	70	9 mc
2N395	5, 11, 15	*	p-n-p	high-freq switch	19	H	−30	200	200	75	4.5 mc
2N396, A	5, 6, 11, 15, 14	**	p-n-p	high-freq switch	19	H	−30	200	200	80	8 mc
2N397	5, 15	**	p-n-p	high-freq switch	19	H	−30	200	200	90	12 mc
2N398	10, 8	**	p-n-p	low-freq switch	17	G	−105	100	50	60	
2N401	1, 13	**	p-n-p	af (power ampl)	24	K	−30	3 A	25 W	40	400 kc
2N404, A	10, 5, 6, 11, 13	**	p-n-p	med-freq switch	17	G	−25	100	120	50	12 mc
2N405	10, 13	*	p-n-p	af (ampl/osc/driver)	5	B	−20	35	150	35	650 kc
2N406	10, 13	*	p-n-p	af (ampl/osc/driver)	10	D	−20	35	150	35	650 kc
2N407	10, 13	*	p-n-p	af (ampl/osc/driver)	5	B	−20	70	150	75	
2N408	10, 13	*	p-n-p	af (ampl/osc/driver)	10	D	−20	70	150	75	
2N409	10, 13	*	p-n-p	if (455-kc ampl)	5	B	−13	15	80	48	6.8 mc
2N410	10, 13	*	p-n-p	if (455-kc ampl)	10	D	−13	15	80	48	6.8 mc
2N411	10, 13	*	p-n-p	rf (540–1640-kc converter)	5	B	−13	15	80	75	10 mc
2N412	10, 13	*	p-n-p	rf (540–1640-kc converter)	10	D	−13	15	80	75	10 mc
2N413, A	5, 7, 14	*	p-n-p	rf (3-mc ampl)	4	B	−30	400		30	2.5 mc
2N414, A	5, 7, 13, 14	*	p-n-p	rf (8-mc ampl)	4	B	−30	400		60	7 mc
2N416	11, 6, 7, 14	***	p-n-p	rf (540–1640-kc ampl)	19	H	−30	400		80	10 mc
2N417	13, 14	***	p-n-p	rf (to 20-mc ampl)	19	H	−30	400		70-250	20 mc
2N420, A	13, 1	**	p-n-p	af (power ampl)	24	K	65	5 A	60 W	40	
2N422	11	**	p-n-p	af (ampl/osc/driver)	19	H	−35	100		50	800 kc
2N425	11, 7, 14	**	p-n-p	med-freq switch	19	H	−30	400	150	30	4 mc
2N426	11, 7, 14	**	p-n-p	med-freq switch	19	H	−30	400	150	40	6 mc
2N427	13, 6, 7, 11, 14	**	p-n-p	med-freq switch	19	H	−30	400	150	60	5 mc
2N428	11, 6, 7, 14	***	p-n-p	med-freq switch	19	H	−30	400	150	80	17 mc
2N438, A	13, 2, 6, 11	**	n-p-n	med-freq switch	19	H	30	400	100	20	2.5 mc
2N439, A	11, 2, 6, 13	***	n-p-n	high-freq switch	19	H	30	400	100	45	5 mc

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	I_C ma	Collector Dissi-pation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N441	2, 15, 4, 8	***	p-n-p	af (power ampl)	25	M	−40	15 A	150 W	30	
2N442	2, 15, 4, 8	***	p-n-p	af (power ampl)	25	M	−50	15 A	150 W	30	
2N443	2	***	p-n-p	af (power ampl)	25	M	−60		85 W	40	
2N448	5	**	n-p-n	if (455-kc ampl)	3	A	15	20	65	25	5 mc
2N449	5	**	n-p-n	if (455-kc ampl)	3	A	15	20	65	72	8 mc
2N450	5	**	p-n-p	high-freq switch	4	B	−20	125	150	30	5 mc
2N456-A	15, 3	***	p-n-p	af (power ampl)	24	K	−40	7 A	50 W	50	430 kc
2N457-A	15, 4	***	p-n-p	af (power ampl)	24	K	−60	7 A	150 W	50	430 kc
2N458-A	15, 4	***	p-n-p	af (power ampl)	24	K	−80	7 A	150 W	50	430 kc
2N460	14	***	p-n-p	gen-purpose ind	19	H	−10	400	200		1.2 mc
2N461	14, 8	***	p-n-p	gen-purpose ind	19	H	−10	400	200		4 mc
2N464	11, 6, 7, 8, 1	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	100	150	26	700 kc
2N465	8, 6, 7, 11, 1	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	100	200	45	800 kc
2N466	8, 6, 7, 11, 1	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−35	100	200	90	1 mc
2N467	8, 6, 7, 11, 1	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−35	100	200	180	1.2 mc
2N499	9, 12	***	p-n-p	rf (100-mc power ampl)	13	F	−30	50	30	8.5	
2N502, A	9, 12	***	p-n-p	vhf (500-mc osc)	15	G	−20		25	45	
2N503	9, 12	***	p-n-p	rf (100-mc ampl)	15	G	−20	50	30	65	
2N504	9, 12	***	p-n-p	rf (50-mc osc)	13	D	−35	50	30	16	
2N508	5	**	p-n-p	af (ampl/osc/driver)	19	H	−16	100	140	125	3.5 mc
2N511, A	15	***	p-n-p	af (power ampl)	24	K	−40	25 A	80 W	40	260 kc
2N515	13	**	n-p-n	if (455-kc ampl)	2	A		10	50	35	2 mc
2N516	13	**	n-p-n	if (455-kc ampl)	2	A		10	50	10	2 mc
2N517	13	**	n-p-n	if (455-kc ampl)	2	A		10	50	40	2 mc
2N519, B	13, 6, 7	**	p-n-p	med-freq switch	19	H	−25	100	100	27	
2N524	13, 5	***	p-n-p	af (ampl/osc/driver)	19	H	−45	500	225	30	2 mc
2N525	5, 13	***	p-n-p	af (ampl/osc/driver)	19	H	−45	500	225	44	2.5 mc
2N526	5, 13	***	p-n-p	af (ampl/osc/driver)	19	H	−45	500	225	64	3 mc
2N527	13, 5	***	p-n-p	af (ampl/osc/driver)	19	H	−45	500	225	81	3.3 mc
2N534	9	**	p-n-p	af (micromin ampl)	12	F	−50	25	25	100	
2N535, A, B	9	***	p-n-p	af (micromin ampl)	12	F	−20	20	50	100	f_{hfb} 2 mc
2N536	9	***	p-n-p	micromin switch	12	F	−20	30	50	150	2 mc
2N539, A	2	***	p-n-p	af (power ampl)	special		−80	3.5 A	30 W	75	200 kc
2N540, A	2	***	p-n-p	af (power ampl)	special		−80	3.5 A	30 W	113	200 kc
2N554	8, 13	*	p-n-p	af (power ampl)	24	K	−30	3 A	2 W	30	8 kc
2N555	8	*	p-n-p	af (power ampl)	24	K	−40	3 A	2 W	40	8 kc
2N557	13	***	n-p-n	med-freq switch	19	H	20	200	100	20	
2N578	10, 7, 14	***	p-n-p	med-freq switch	17	G	−20	400	120	15	5 mc
2N579	10, 7, 14	***	p-n-p	med-freq switch	17	G	−20	400	120	30	8 mc
2N581	10, 7, 14	**	p-n-p	med-freq switch	17	G	−18	100	80	30	8 mc
2N582	10, 7, 14	***	p-n-p	high-freq switch	17	G	−25	100	120	60	18 mc
2N583	10	**	p-n-p	med-freq switch	10	D	−18	100	80	30	8 mc
2N584	10	***	p-n-p	high-freq switch	10	D	−25	100	120	60	18 mc
2N585	13, 10	*	n-p-n	med-freq switch	19	H	25	200	120	20	3 mc
2N586	10	**	p-n-p	low-freq switch	6	B	−45	250	250	60	
2N587	13	***	n-p-n	med-freq switch	19	H	40	200	150	20	
2N588	9, 12	**	p-n-p	vhf (ampl/osc)	13	D	−15	50	30		250 mc
2N591	10	*	p-n-p	af (ampl/osc)	10	D	−32	40	50	70	700 kc
2N597	9	***	p-n-p	rf (ampl/switch)	15	G	−45	500	250	70	f_{hfb} 8 mc
2N598	9	***	p-n-p	rf (ampl/switch)	15	G	−35	500	250	125	f_T 8 mc
2N600	9	***	p-n-p	high-power pulse ampl	16	G	−35	400	750	125	10 mc
2N618	8	***	p-n-p	af (high-gain power ampl)	24	K	−80	10 A	90 W	100	5 kc
2N627	8	***	p-n-p	af (power ampl)	24	K	−40	10 A	90 W	20	5 kc
2N628	8	***	p-n-p	af (power ampl)	24	K	−60	10 A	90 W	175	5 kc
2N631	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−25	100	168	150	

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	MAX RATINGS I_C ma	MAX RATINGS Collector Dissipation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N632	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−30	100	168	100	
2N633	11, 7	**	p-n-p	af (ampl/osc/driver)	19	H	−35	100	168	60	
2N634	5, 2	***	n-p-n	high-freq switch	19	H	20	300	150	15	8 mc
2N635	2	***	n-p-n	high-freq switch	17	G	20		150	25	10 mc
2N636-A	2, 13	***	n-p-n	high-freq switch	17	G	20		150	35	15 mc
2N641†	10	**	p-n-p	rf (ampl/osc)	7	C	−34	10	80	60	42 mc
2N642†	10	**	p-n-p	rf (converter)	7	C	−34	10	80	60	42 mc
2N643	10	***	p-n-p	High-freq switch	17	G	−30	100	120	45	
2N647	10	**	n-p-n	af (ampl/osc/driver)	10	D	25	100	100	70	
2N649	10	**	n-p-n	af (ampl/osc/driver)	10	D	20	100	100	65	
2N650, A	8	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	500	200	49	1.5 mc
2N651, A	8	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	500	200	80	2 mc
2N652, A	8	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	500	200	130	2.5 mc
2N653	8	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−30	250	200	49	1.5 mc
2N654	8	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−30	250	200	80	2 mc
2N655	8	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−30	250	200	130	2.5 mc
2N658	11	***	p-n-p	high-curr switch	19	H	−25	1 A		50	5 mc
2N659	11	***	p-n-p	high-curr switch	19	H	−25	1 A		70	10 mc
2N662	11	***	p-n-p	high-curr switch	19	H	−25	1 A		90	15 mc
2N669	8, 4	**	p-n-p	af (power ampl)	24	K	−40	3 A	10 W	90	5 kc
2N670	9	***	p-n-p	pulse ampl–high-curr switch	14	G	−40	2 A	300	100	700 kc
2N671	9	***	p-n-p	pulse ampl–high-curr switch	18	G	−40	2 A	1 W	100	700 kc
2N672	9	***	p-n-p	pulse-ampl–high-curr switch	14	G	−25	2 A	300		
2N673	9	***	p-n-p	pulse ampl–high-curr switch	18	G	−25	2 A	1 W		
2N674	9	***	p-n-p	pulse ampl–high-curr switch	14	G	−75	2 A	300	160	f_{hfb} 100 kc
2N677, A	13, 1	***	p-n-p	power switch	24	K	−50	15 A	50 W	35	400 kc
2N679	13	**	n-p-n	med-freq switch	19	H	25	200	150	20	
2N680	15	**	p-n-p	af (ampl/osc/driver)	1	A	−20	150	150	35	
2N700	8	***	p-n-p	rf/if (osc/ampl)	21	J	−25	50	75	10	800 mc
2N705	8	***	p-n-p	uhf switch	21	H	−15	50	150	40	300 mc
2N706, A, B	8	***	n-p-n	uhf switch	21	H	25	200	300	40	400 mc
2N710	8	***	p-n-p	ultra-high-speed switch	21	H	15	50	150	50	300 mc
2N711	15	***	p-n-p	ultra-high-speed switch	21	H	−12	50	300	20	300 mc
2N741, A	8	***	p-n-p	rf/if (osc/ampl)	21	H	−15	100	150	25	300 mc
2N835	8	***	n-p-n	uhf switch	21	H	25	200	300	40	450 mc
2N960	8	***	p-n-p	uhf switch	21	H	−15		150	20	460 mc
2N961	8	***	p-n-p	uhf switch	21	H	−12		150	20	460 mc
2N962	8	***	p-n-p	uhf switch	21	H	−12		150	20	460 mc
2N964	8	***	p-n-p	uhf switch	21	H	−15		150	40	460 mc
2N965	8	***	p-n-p	uhf switch	21	H	−12		150	40	460 mc
2N966	8	***	p-n-p	uhf switch	21	H	−12		150	40	460 mc
2N968	8	***	p-n-p	uhf switch	21	H	−15		150	20	320 mc
2N969	8	***	p-n-p	uhf switch	21	H	−12		150	20	320 mc
2N970	8	***	p-n-p	uhf switch	21	H	−12		150	20	320 mc
2N971	8	***	p-n-p	uhf switch	21	H	−7		150	20	320 mc
2N972	8	***	p-n-p	uhf switch	21	H	−15		150	40	320 mc
2N973	8	***	p-n-p	uhf switch	21	H	−12		150	40	320 mc
2N974	8	***	p-n-p	uhf switch	21	H	−12		150	40	320 mc
2N975	8	***	p-n-p	uhf switch	21	H	−7		150	40	320 mc
2N1000	2	***	n-p-n	med-freq switch	17	G	40		150	40	7 mc
2N1008	13, 1	**	p-n-p	af (ampl/osc/driver)	19	H	−40	300	150	85	500 kc
2N1010	10	***	n-p-n	af (ampl/osc)	10	D	10	2	20	35	2 mc
2N1012	2	***	n-p-n	med-freq switch	17	G	40		150	40	3 mc
2N1023	10	***	p-n-p	rf (50-mc ampl)	11	E	−40	10	1.5	60	50 mc
2N1038	15	***	p-n-p	af (power ampl)	27	H	−40	3 A	20 W	60	10 kc
2N1039	15	***	p-n-p	af (power ampl)	27	H	−60	3 A	20 W	60	10 kc
2N1056	5	***	p-n-p	relay driver	4	B	−70	300	240	32	1 mc
2N1058	13	**	n-p-n	rf (540–1640-kc converter)	2	A			50	23	4 mc
2N1059	13	*	n-p-n	af (ampl/osc/driver)	2	A	20	100	180	75	10 kc
2N1066	10	***	p-n-p	rf (50-mc ampl)	20	J	−40	10	1.5	60	120 mc
2N1078	2	***	p-n-p	af (power ampl)	special		−60	3 A	23 W	90	
2N1086, A	5	**	n-p-n	rf (540–1640-kc conv/osc/mixer)	3	A	9	20	65	40	8 mc
2N1087	5	**	n-p-n	rf (540–1640-kc conv/osc/mixer)	3	A	9	20	65	40	8 mc
2N1090	11, 2, 10	***	n-p-n	med-freq switch	19	H	25	400	120	50	5 mc
2N1091	11, 2, 10	***	n-p-n	med-freq switch	19	H	25	400	120	70	10 mc

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	MAX RATINGS I_C ma	MAX RATINGS Collector Dissipation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N1097	5	**	p-n-p	af (ampl/osc)	19	B	16	100	140	55	2 mc
2N1098	5	**	p-n-p	af (ampl/osc)	19	B	−16	100	140	45	2.5 mc
2N1099	2	***	p-n-p	af (power ampl)	TO 36	TO 36	−80		70 W	70	
2N1100	2	***	p-n-p	af (power ampl)	TO 36	TO 36	−100		70 W	50	
2N1101	13	*	n-p-n	af (ampl/osc/driver)	2	A	20	100	180	35	10 kc
2N1102	13	*	n-p-n	af (ampl-osc/driver)	2	A	40	100	180	35	10 kc
2N1107	15	***	p-n-p	rf (540–1640-kc ampl/osc/conv)	1	A	−16	5	30	34	40 mc
2N1108	15	**	p-n-p	rf (540–1640-kc ampl/osc/conv)	1	A	−16	5	30	33	35 mc
2N1109	15	**	p-n-p	rf (540–1640-kc ampl/osc/conv)	1	A	−16	5	30	20	30 mc
2N1110	15	**	p-n-p	rf (540–1640-kc ampl/osc/conv)	1	A	−16	5	30	29	35 mc
2N1111, A, B	15	**	p-n-p	rf (540–1640-kc ampl/osc/conv)	1	A	−20	5	30	25	35 mc
2N1115	5	**	p-n-p	med-freq switch	4	B	−20	125	500		5 mc
2N1121	5	**	n-p-n	if (455-kc ampl)	3	A	15	20	65	72	8 mc
2N1123	9	***	p-n-p	med-freq switch/ampl	16	G	−45	500	750	70	f_{hfb} 5 mc
2N1124	9	**	p-n-p	med-freq switch/ampl	14	G	−40	250	300	125	f_{hfb} 1.3 mc
2N1125	9	***	p-n-p	med-freq switch/ampl	14	G	−40	250	300	95	f_{hfb} 2 mc
2N1128	9	**	p-n-p	af (ampl/osc/driver)	14	G	−25	250	150	120	f_{hfb} 1.25 mc
2N1129	9	**	p-n-p	af (ampl/osc/driver)	14	G	−25	250	150	165	f_{hfb} 750 kc
2N1130	9	**	p-n-p	af (ampl/osc/driver)	14	G	−30	250	150	110	f_{hfb} 950 kc
2N1144	5	**	p-n-p	af (ampl/osc)	4	B	−16	100	140	55	2 mc
2N1145	5	**	p-n-p	af (ampl/osc)	4	B	−16	100	140	42	2.5 mc
2N1168	4	***	p-n-p	af (power ampl)	24	K	−50	5 A		110	
2N1172	4	***	p-n-p	af (med-power ampl)	26	N	−40	1.5 A		30-90	
2N1177	10	***	p-n-p	rf (120-mc ampl)	9	C	−30	10	80	100	140 mc
2N1178	10	***	p-n-p	rf (120-mc osc)	9	C	−30	10	80	40	140 mc
2N1179	10	***	p-n-p	rf (120-mc mixer)	9	C	−30	10	80	80	140 mc
2N1180	10	**	p-n-p	rf (10.7-mc ampl)	9	C	−30	10	80	80	140 mc
2N1183	10	**	p-n-p	af (power ampl)	22	G	−45	3 A	1 W	40	
2N1184	10	***	p-n-p	af (power ampl)	22	G	−45	3 A	1 W	80	
2N1185	8	***	p-n-p	af (ampl/osc/driver/switch)	17	G	−45	500	200	300	3 mc
2N1186	8	***	p-n-p	af (ampl/osc/driver/switch)	17	G	−60	500	200	50	1.5 mc
2N1187	8	***	p-n-p	af (ampl/osc/driver/switch)	17	G	−60	500	200	80	2 mc
2N1188	8	***	p-n-p	af (ampl/osc/driver/switch)	17	G	−60	500	200	160	2.5 mc
2N1191	8	**	p-n-p	af (ampl/osc/driver/switch)	19	G	−40	200	175	40	1.5 mc
2N1192	8	**	p-n-p	af (ampl/osc/driver/switch)	19	G	−40	200	175	75	2 mc
2N1193	8	**	p-n-p	af (ampl/osc/driver/switch)	19	G	−40	200	175	160	2.5 mc
2N1194	8	**	p-n-p	af (ampl/osc/driver/switch)	17	G	−40	200	200	350	3 mc
2N1216	10	***	p-n-p	high-speed switch	17	G	−25	100	75		
2N1224	13, 10	**	p-n-p	rf (12.5-mc ampl)	20	J	−40	10	120	140	30 mc
2N1226	10	***	p-n-p	rf (high-freq ampl/osc/conv)	20	J	−60	10	120	60	30 mc
2N1264	13	*	p-n-p	if (455-kc ampl)	8	C	−20	10	50	15	
2N1265	13	*	p-n-p	af (ampl/osc)	2	A		100	50	25	600 kc
2N1266	13	*	p-n-p	if (455-kc ampl)	2	A			80	10	
2N1273	15	*	p-n-p	af (ampl/osc/driver)	19	G	−15	150	150	75	2 mc
2N1274	15	*	p-n-p	af (ampl/osc/driver)	19	G	−25	150	150	75	2 mc
2N1291	2	***	p-n-p	af (power ampl)	24	K	−35	3 A	23 W	90	
2N1292	2	***	n-p-n	af (power ampl)	24	K	35	3 A	23 W	90	
2N1293	2	***	p-n-p	af (power ampl)	24	K	−60	3 A	23 W	90	
2N1294	2	***	n-p-n	af (power ampl)	24	K	60	3 A	23 W	90	
2N1295	2	***	p-n-p	af (power ampl)	24	K	−80	3 A	23 W	90	
2N1297	2	***	p-n-p	af (power ampl)	24	K	−100	3 A	23 W	90	
2N1300	10	***	p-n-p	high-speed switch	17	G	−13	100	150	50	40 mc
2N1302	15, 13	**	n-p-n	high-speed switch	19	H	25	300	150	50	4.5 mc
2N1303	15, 13	**	p-n-p	high-speed switch	19	H	−30	300	150	50	4.5 mc
2N1304	15, 5, 13	**	n-p-n	high-speed switch	19	H	25	300	150	70	8 mc
2N1305	15, 13	**	p-n-p	high-speed switch	19	H	−30	300	150	70	8 mc
2N1306	15, 5, 13	***	n-p-n	high-speed switch	19	H	25	300	150	100	12 mc
2N1307	15, 13	***	p-n-p	high-speed switch	19	H	−30	300	150	100	12 mc
2N1308	15, 5, 13	***	n-p-n	high-speed switch	19	H	25	300	150	150	20 mc
2N1309	15, 13	***	p-n-p	high-speed switch	19	H	−30	300	150	150	20 mc
2N1313	14	***	p-n-p	high-speed, high-curr switch	19	H	−30	400	180	80	8 mc
2N1320	2	***	p-n-p	af (driver/switch)	29	O	−35	3 A	23 W	90	
2N1322	2	***	p-n-p	af (driver/switch)	29	O	−60	3 A	23 W	90	

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	MAX RATINGS I_C ma	MAX RATINGS Collector Dissipation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N1324	2	***	p-n-p	af (driver/switch)	29	O	−80	3 A	23 W	90	
2N1326	2	***	p-n-p	af (driver/switch)	29	O	−100	3 A	23 W	90	
2N1328	2	***	p-n-p	af (driver/switch)	28	P	−35	3 A	23 W	90	
2N1331	2	***	p-n-p	af (driver/switch)	28	P	−80	3 A	23 W	90	
2N1333	2	***	p-n-p	af (driver/switch)	28	P	−100	3 A	23 W	90	
2N1359	8	***	p-n-p	af (power ampl)	24	K	−50	3 A	90 W	55	10 kc
2N1360	8	***	p-n-p	af (power ampl)	24	K	−50	3 A	90 W	90	8.5 kc
2N1362	8	***	p-n-p	af (power ampl)	24	K	−100	3 A	90 W	55	10 kc
2N1370	15	*	p-n-p	af (ampl/osc/driver)	19	G	−25	150	150	100	2 mc
2N1371	15, 13	**	p-n-p	af (ampl/osc/driver)	19	G	−45	150	150	100	2 mc
2N1372	13, 15	*	p-n-p	af (ampl/osc/driver/switch)	19	H	−25	200	150	60	1.5 mc
2N1373	13, 15	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	200	150	60	1.5 mc
2N1374	13, 15	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−25	200	150	120	2 mc
2N1375	13, 15	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−45	200	150	120	2 mc
2N1376	13, 15	**	p-n-p	af (ampl/osc/driver/switch)	19	H	−25	200	150	130	2 mc
2N1377	15	**	p-n-p	af (ampl/osc/driver/switch)	19	G	−45	200	250	120	2 mc
2N1378	15	**	p-n-p	af (ampl/osc/driver/switch)	19	G	−12	200	250	200	3 mc
2N1379	15	**	p-n-p	af (ampl/osc/driver/switch)	19	G	−25	200	250	200	3 mc
2N1380	13, 15	*	p-n-p	af (ampl/osc/driver/switch)	19	H	−12	200	150	200	2 mc
2N1381	13, 15	*	p-n-p	af (ampl/osc/driver/switch)	19	H	−25	50	150	200	2 mc
2N1382	15	**	p-n-p	af (driver/push-pull output)	19	G	−25	200	200	100	2 mc
2N1383	15	**	p-n-p	af (driver/push-pull output)	19	G	−25	200	200	100	1.5 mc
2N1395	10	***	p-n-p	rf (1.5–12.5-mc ampl)	20	J	−40	10	120	90	30 mc
2N1396	10	***	p-n-p	rf (30-mc ampl)	20	J	−40	10	120	90	100 mc
2N1397	10	***	p-n-p	rf (50-mc ampl)	20	J	−40	10	120	90	120 mc
2N1400	15	***	p-n-p	small-signal ampl	20	O	−30	10	50	5 @ 150 mc	
2N1401	15	***	p-n-p	small-signal ampl	20	O	−30	10	50	5 @ 100 mc	
2N1402	15	***	p-n-p	rf (vhf ampl/osc)	20	J	−30	5	35	2	
2N1404	15	**	p-n-p	high-speed switch	19	H	−25	300	150	30	8 mc
2N1411	2	***	p-n-p	med-freq switch	13	G	−5	50	25	125	5 mc
2N1416	9	**	p-n-p	af (ampl/osc/driver)	14	F	−18	150	250	110	600 kc
2N1425	10	*	p-n-p	if (455-kc ampl)	7	C	−24	10	80		33 mc
2N1426	10	*	p-n-p	rf (540–1640-kc converter)	7	C	−24	10	80		33 mc
2N1431	13	**	n-p-n	af (ampl/osc/driver)	2	A	25	100	180	125	10 kc
2N1433	2	***	p-n-p	af (power ampl/switch)			−80	3.5 A	30 W	50	200 kc
2N1434	2	***	p-n-p	af (power ampl/switch)			−80	3.5 A	30 W	115	200 kc
2N1435	2	***	p-n-p	af (power ampl/switch)			−80	3.5 A	30 W	175	200 kc
2N1437	2	***	p-n-p	af (power ampl/switch)	28	P	−100	3 A	23 W	40	4 kc
2N1438	2	***	p-n-p	af (power ampl/switch)	29	O	−100	3 A	23 W	40	4 kc
2N1453	2	***	p-n-p	af (power ampl/switch)	28	P	−30	5 A	43 W	90	5 kc
2N1454	2	***	p-n-p	af (power ampl/switch)	28	P	−30	5 A	43 W	150	5 kc
2N1455	2	***	p-n-p	af (power ampl/switch)	28	P	−60	5 A	43 W	90	5 kc
2N1456	2	***	p-n-p	af (power ampl/switch)	28	P	−60	5 A	43 W	150	5 kc
2N1457	2	***	p-n-p	af (power ampl/switch)	28	P	−80	5 A	43 W	90	5 kc
2N1458	2	***	p-n-p	af (power ampl/switch)	28	P	−80	5 A	43 W	150	5 kc
2N1461	2	***	p-n-p	af (power ampl/switch)	29	O	−30	5 A	43 W	90	5 kc
2N1462	2	***	p-n-p	af (power ampl/switch)	29	O	−30	5 A	43 W	150	5 kc
2N1463	2	***	p-n-p	af (power ampl/switch)	28	P	−60	5 A	43 W	90	5 kc
2N1464	2	***	p-n-p	af (power ampl/switch)	28	P	−60	5 A	43 W	150	5 kc
2N1465	2	***	p-n-p	af (power ampl/switch)	29	O	−120	3 A	20 W	40	
2N1466	2	***	p-n-p	af (power ampl/switch)	28	P	−120	3 A	20 W	40	
2N1478	9	**	p-n-p	high-speed switch	15	G	−30	400	250	70	8 mc
2N1499	9	***	p-n-p	high-speed switch	15	G	−20	100	60	70	f_T 100 mc
2N1504	2	***	p-n-p	af (power ampl/switch)	16	L	−80	3 A	23 W	60	4 kc
2N1524	10	*	p-n-p	if (455-kc ampl)	10	D	−24	10	80	60	33 mc
2N1525	10	*	p-n-p	if (455-kc ampl)	5	B	−24	10	80	60	33 mc
2N1526	10	*	p-n-p	rf (540–1640-kc converter)	10	D	−24	10	80	130	33 mc
2N1527	10	*	p-n-p	rf (540–1640-kc converter)	5	B	−24	10	80	130	33 mc
2N1529	8	**	p-n-p	af (power ampl)/high-curr switch	24	K	−40	5 A	90 W	30	10 kc
2N1530	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−60	5 A	90 W	30	10 kc
2N1531	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−80	5 A	90 W	30	10 kc
2N1532	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−100	5 A	90 W	30	10 kc
2N1534	8, 4	***	p-n-p	af (power ampl)/high-curr switch	24	K	−40	5 A	90 W	55	8.5 kc
2N1535	8, 4	***	p-n-p	af (power ampl)/high-curr switch	24	K	−60	5 A	90 W	55	8.5 kc
2N1536	8, 4	***	p-n-p	af (power ampl)/high-curr switch	24	K	−80	5 A	90 W	55	8.5 kc
2N1539	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−40	5 A	90 W	75	4 kc

TYPE NO.	MFR.	PRICE	TYPE	TYPICAL APPLICATION	CASE	BASE	MAX RATINGS V_{CB} v	MAX RATINGS I_C ma	MAX RATINGS Collector Dissipation mw	h_{fe} or h_{FE}	Alpha Cutoff Frequency
2N1540	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−60	5 A	90 W	75	4 kc
2N1541	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−80	5 A	90 W	75	4 kc
2N1544	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−40	5 A	90 W	125	4 kc
2N1545	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−60	5 A	90 W	125	4 kc
2N1546	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−80	5 A	90 W	125	4 kc
2N1549	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−40	15 A	90 W	20	10 kc
2N1553	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−40	15 A	90 W	40	6 kc
2N1554	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−60	15 A	90 W	40	6 kc
2N1557	8	***	p-n-p	af (power ampl)/high-curr switch	24	K	−40	15 A	90 W	75	5 kc
2N1605	13	**	n-p-n	medium-freq switch	19	H	25	100	150	40	4 mc
2N1611	4	***	p-n-p	af (med-power ampl)	26	N	−60	1.5 A		50	
2N1631	10	**	p-n-p	rf (high-freq ampl)	5	B	−34	10	80	80	45 mc
2N1632	10	**	p-n-p	rf (high-freq ampl)	10	D	−34	10	80	80	45 mc
2N1633	10	**	p-n-p	if (455-kc ampl)	5	B	−34	10	80	75	40 mc
2N1634	10	**	p-n-p	if (455-kc ampl)	10	D	−34	10	80	75	40 mc
2N1635	10	**	p-n-p	rf (high-freq converter)	5	B	−34	10	80	75	45 mc
2N1636	10	**	p-n-p	rf (high-freq converter)	10	D	−34	10	80	75	45 mc
2N1637	10	**	p-n-p	rf (high-freq ampl)	10	D	−34	10	80	80	45 mc
2N1638	10	**	p-n-p	if (455-kc ampl)	10	D	−34	10	80	75	40 mc
2N1639	10	**	p-n-p	rf (high-freq converter)	10	D	−34	10	80	75	40 mc
2N1681	14	**	p-n-p	high-freq switch	19	H	−30	200	180	70	5 mc
2N1705	14	**	p-n-p	af (driver)	19	H	−18	400	200	110	4 mc
2N1706	14	**	p-n-p	af (driver)	19	H	−25	400	200	90	3 mc
2N1707	14	**	p-n-p	af (driver)	19	H	−30	400	200	100	3 mc
2N1726	9	**	p-n-p	rf ampl	15	G	−20	50	60	60	150 mc
2N1727	9	**	p-n-p	if (converter/mixer/osc)	15	G	−20	50	60	60	150 mc
2N1728	9	**	p-n-p	if ampl	15	G	−20	50	60	60	150 mc
2N1742	9	***	p-n-p	vhf ampl	15	G	−20		60	33	
2N1743	9	***	p-n-p	vhf mixer	15	G	−20		60	33	
2N1744	9	***	p-n-p	vhf osc	15	G	−20		60	33	
2N1745	9	**	p-n-p	45-mc if ampl	15	G	−20	50	60	33	
2N1746	9	**	p-n-p	4.5-mc if ampl	15	G	−20	50	60	60	235 mc
2N1747	9	**	p-n-p	if ampl	15	G	−20	50	60	60	
2N1748, A	9	**	p-n-p	video driver	15	G	−25	50	60	45	100 mc
2N1749	9	**	p-n-p	video output	15	G	−40	10	75	45	100 mc
2N1750	9	**	p-n-p	horiz osc	13	F	−14	5	15	40	30 mc
2N1752	9	**	p-n-p	sync separator	15	G	−12	50	60	250	106 mc
2N1785	9	**	p-n-p	rf ampl	15	G	−10	50	45	60	125 mc
2N1786	9	**	p-n-p	converter/mixer/osc	15	G	−10	50	45	60	125 mc
2N1787	9	**	p-n-p	if ampl	15	G	−15	50	45	60	125 mc
2N1788	9	**	p-n-p	rf ampl	15	G	−35	50	60	60	150 mc
2N1789	9	**	p-n-p	converter	15	G	−35	50	60	60	150 mc
2N1790	9	**	p-n-p	if ampl	15	G	−35	50	60	60	150 mc
2N1808	15	*	n-p-n	high-freq switch	19	H	25	300	150		4 mc
2N1864	9	*	p-n-p	if ampl (455-kc)	15	G	−20	50	60	60	125 mc
2N1865	9	**	p-n-p	if ampl	15	G	−20	50	60	60	
2N1866	9	**	p-n-p	if ampl	15	G	−35	50	60	60	
2N1867	9	**	p-n-p	if ampl	15	G	−35	50	60	60	
2N1868	9	**	p-n-p	if ampl	15	G	−20	50	60	33	
2N1966	14	***	p-n-p-n	general-purpose indust switch	19	P	−35	200	120		
2N1971	4	***	p-n-p	af (power ampl)	24	K	−80	4 A		25-60	
2N1994	15	**	p-n-p	bi-directional ampl	19	H	−30	300	150	15	3 mc
2N1995	15	***	p-n-p	bi-directional ampl	19	H	−25	300	150	25	5 mc
2N1997	15	***	p-n-p	med-power switch	19	H	−45	400	250	50	4 mc
2N1998	15	***	p-n-p	med-power switch	19	H	−35	400	250	80	7 mc
2N2042, A	8	***	p-n-p	af (ampl/osc/driver/switch)	17	G	−105	200	200	35	500 kc
2N2043, A	8	***	p-n-p	af (ampl/osc/driver/switch)	17	G	−105	200	200	70	750 kc
2N2077, A	8	***	p-n-p	af (high-power ampl/switch)	25	M	−50	15 A	170 W	30	5 kc
2N2078, A	8	***	p-n-p	af (high-power ampl/switch)	25	M	−40	15 A	170 W	30	5 kc
2N2081	8	***	p-n-p	af (high-power ampl/switch)	25	M	−50	15 A	170 W	50	5 kc
2N2082, A	8	***	p-n-p	af (high-power ampl/switch)	25	M	−40	15 A	170 W	50	5 kc

f_T=gain bandwidth product

By DELLROYE D. DARLING*

ANTI-CHATTER CAPACITORS

To keep plate relays quiet . . . use a capacitor, a resistor or a combination of both

THE word "chatter" has many meanings to many people. But to an industrial electronic technician, it means only one thing: "Some relay is buzzing like crazy; it seems to be pulled in, but the load is not receiving normal power."

How do we cure the situation? Hook a capacitor across the relay coil! Like the solutions to a lot of other problems, this one sounds suspiciously simple, and it is.

First, let's figure out *why* the relay chatters. Fig. 1 shows the circuit of a simple on–off type of electronic timer that might be used for life-testing relays, solenoid valves, etc. Relays in this circuit are used in the same way as in many common industrial circuits. RY1 and RY2 are connected in the anode (plate) circuits of thyratron tubes. Each relay has a capacitor-resistor circuit across its coil.

The timing circuit is a little unusual because of the placement of the timing capacitors, and exactly how they charge may not be apparent. On negative half cycles the grid end of these capacitors is charged negatively through grid-cathode conduction in the thyratron from the upper side of the line (Fig. 1, from point A via the ac relay coil to cathode and thence to grid). The current drawn to charge these capacitors is very small and does not energize RY3.

RY1 and RY2 require protection against chatter because they are being energized by the plate current of electron tubes.

The plate supply for thyratrons V1 and V2 is raw ac from the line. This is common practice in industrial gas-tube circuits. Although we might not think of it right off, C1 and V2 are actually rectifiers, since they can pass current only when their plates are positive with respect to their cathodes. That means that RY1 and RY2 have current flowing through them only when line A is positive, unless we arrange some other supply (Fig. 2).

Filter the ripple

Since we apply pulsating dc to the relay coils, though we would prefer smooth dc, why not filter the ripple, as we do in a radio or TV power supply? That is just what has been done here. An electrolytic capacitor is connected across each relay coil to store energy when the tube conducts, and release it to keep the relay pulled in when the line polarity keeps the tube from conducting.

But why the 100-ohm resistor in series with the capacitor? It serves the same purpose as the surge resistor in a radio or television power supply.

At the time the thyratron begins to fire (conduct), the capacitor across the relay coil is completely discharged. Like any other capacitor in this condition, it represents almost zero impedance between the thyratron plate and line A. If we leave the thyratron connected across the line for even an instant with no impedance in series to limit current flow, the tube will certainly be damaged. The 100-ohm resistor limits plate current until the capacitor begins to charge. (The resistance used here is not critical, and 100 ohms is a common value.)

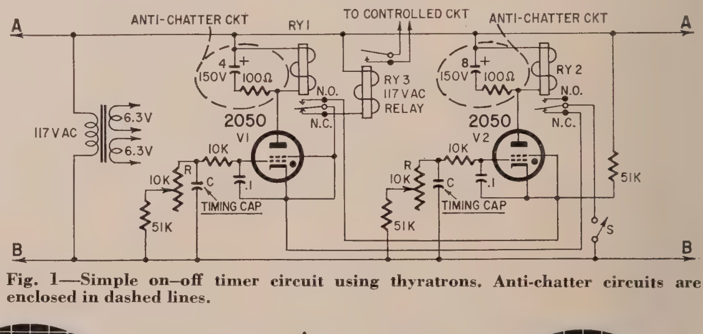


Fig. 1—Simple on–off timer circuit using thyratrons. Anti-chatter circuits are enclosed in dashed lines.

*Director, industrial electronics, Radio Electronic Television Schools, Detroit 26, Mich.

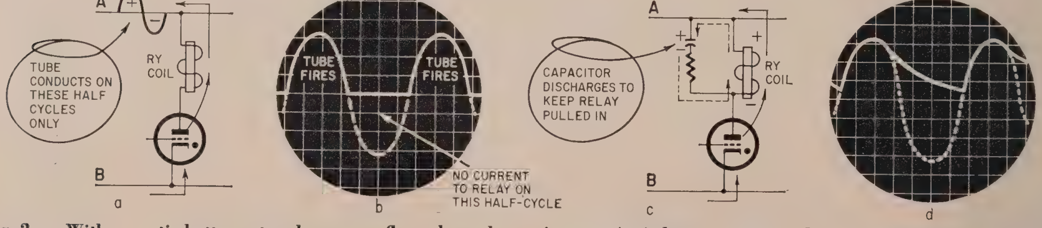


Fig. 2-a—With no anti-chatter network, current flows through coil only when A is positive, because of tube's rectifying action. b—Waveform across relay coil with no chatter protection. c—Anti-chatter capacitor keeps current flowing during "off" half-cycles. d—Waveform across relay with anti-chatter network.

How much capacitance should we use? We can be very scientific and calculate the time constant of the capacitor across the resistance of the relay coil, but the trouble is that the amount of current required to keep the relay pulled in varies, even between relays that are supposed to be identical. Because of this, even design engineers usually "cut and try" or call on previous experience. Use a value that just stops the chatter; too large a capacitor may hold the relay in after it is *supposed* to fall out, which will slow the response of the circuit.

Sometimes a smaller value of capacitance will stop chatter better than a large one. This happens because when we hit the right value of capacitance to make the inductance of the relay coil resonate at the supply frequency (60 cycles), quite a large current circulates in the relay coil-capacitor circuit, just as in any other resonant circuit. This "resonant" current does a fine job of keeping the relay pulled in (Fig. 3).

Use a resistor

Another way to prevent chatter, commonly used with small ac-type relays, is to connect just a resistance across the coil. At first this looks pretty strange, since a resistance is just about opposite to a capacitor in action.

The relay coil is an inductance, and we know that a collapsing magnetic field (like the one we have in the core of the relay when the tube stops conducting) releases quite a lot of energy. The trouble is, with just the relay coil in the tube's plate circuit, there is no complete circuit for the inductive current to flow through, and this energy is wasted.

If we connect a suitable resistance across the coil, the inductive current from the coil can keep flowing on the tube's "off" half-cycle and keep the relay pulled in to prevent chatter. About 2,000 ohms is a common value for this resistor. Too large a value does not stop the chatter, while a too-small resistance causes the tube to draw too much plate current and may cause trouble.

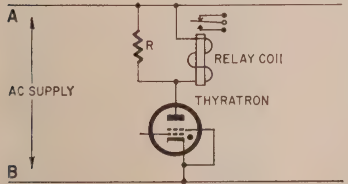


Fig. 3—Sometimes a simple resistance connected across a relay coil can stop relay chatter.

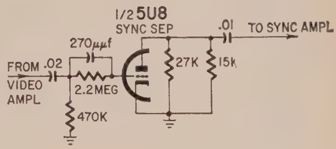
Now, let's go back to Fig. 1. How come the 117-volt ac relay (RY3) doesn't need anti-chatter protection? When it is energized, it's connected right across the ac supply line; it receives full-cycle ac, and it won't chatter anyway. END

WHAT'S YOUR EQ?

It's stumper time again. Here are three little beauties that will give you a run for the money. They may look simple, but double-check your answers before you say you've solved them. For those that get stuck, or think that it just can't be done, see the answers next month. If you've got an interesting or unusual answer send it to us. We are getting so many letters we can't answer individual ones, but we'll print the more interesting solutions (the ones the original authors never thought of). Also, we're in the market for puzzlers and will pay $10 and up for each one accepted. Write to EQ Editor, Radio-Electronics, 154 West 14 St., New York, N. Y.

What's The Sync Trouble?

The Emerson TV had no sync. Using his scope, the technician found no sync on the plate of 5U8 (see schematic). Video to the grid was normal. Using a vtvm, he found a negative 12 volts on the grid, due to grid rectification, when the set was tuned to a station. Off-station the grid voltage dropped to —3. Next he measured the plate voltage and found it to be 60—on station or off! The tube was good and the socket was OK. You have the facts—what's the trouble?—*Wayne Lemons*



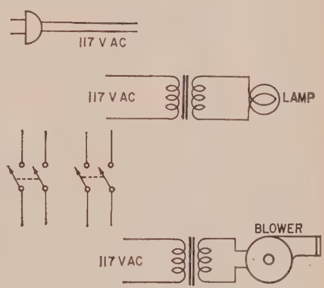
Correct Switching

The life of the high-intensity lamp shown below is reduced to 30 seconds if external air cooling is not provided. It is therefore necessary to assure that the blower is always the first to be turned on and the last to be turned off.

Given:

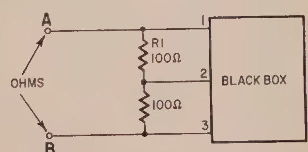
2 stdp switches
1 blower with stepdown transformer
1 high-intensity lamp with stepdown transformer
1 117-vac power cord

Wire the five basic components so that no matter which of the two switches is activated first, the blower will be turned on first and also, no matter which of the two switches is deactivated first, the blower will be the last to be turned off.—*Max J. Fuchs*



The Infinite Black Box

With the Black Box and external resistors shown in the drawing, an ohmmeter connected between terminals A and B reads infinite resistance. What active circuit is in the box?—*Richard L. Koelker*

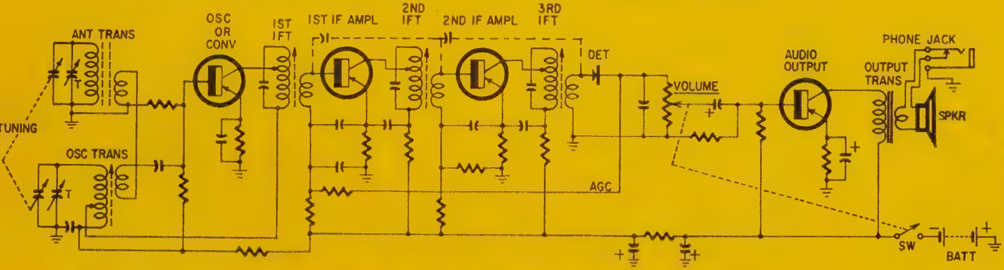


Radio Troubleshooting Chart II

By LEONARD D'AIRO

Last month we printed a systematic troubleshooting chart for radios. This month we look at a transistor radio. Again the chart demonstrates a methodical approach to troubleshooting and cannot be followed too literally, as procedures will necessarily vary somewhat from set to set. However, as a basic guide, you will find it hard to beat.

The chart this month is prepared by Leonard D'Airo, author of *Servicing Transistor Radios.*



RADIO DEAD—NO NOISE FROM SPEAKER

Check Battery Voltage at Terminals.

VOLTAGE OK

DEFECTIVE SWITCH

Clean switch contacts.

Replace switch.

SWITCH OK

a) Leaky or shorted supply filter capacitor.
b) Shorted bypass capacitor.
c) Poor phone jack contact.
d) Defective transistor.
e) Defective speaker or output transformer.

NO VOLTAGE

Replace battery.

Check battery terminals for corrosion.

RADIO DEAD—HISS FROM SPEAKER

Check voltage at collectors of audio transistors.

VOLTAGE OK

Put finger on base terminal of audio output transistor. A hum should be heard in the speaker.

VOLTAGE LOW

Replace battery.

SOUND HEARD

With a metal probe (such as a screwdriver) touch base terminals of second and first if transistors. Sounds should be heard.

NO SOUND

Defective transistor.

SOUND HEARD

Touch base terminal of oscillator or converter transistor.

NO SOUND

a) Open base winding 2nd or 3rd if transformer.
b) Open collector winding 2nd or 3rd if transformer.
c) Shorted bypass capacitor.
d) Defective transistor.

SAME SOUNDS

a) Shorted bypass capacitor.
b) Shorted coupling capacitor.
c) Defective oscillator transistor.
d) Open or shorted oscillator coil.
e) Open or shorted antenna coil.

NO SOUND

a) Defective oscillator transistor.
b) Open or shorted oscillator coil.
c) Shorted bypass capacitor.
d) Open 1st if collector winding.

SET OPERATES ABNORMALLY

Weak Signals, Noise, Distortion, Etc.

OSCILLATOR
(CONVERTER)

WEAK SIGNAL, LOW END

a) *Defective transistor.*
b) *Misadjusted oscillator coil.*

WEAK SIGNAL, HIGH END

a) *Defective transistor*
b) *Broken or cracked antenna coil core.*
c) *Misaligned antenna coil.*

HIGH FREQUENCY CUT OUT

a) *Open emitter bypass capacitor.*
b) *Defective transistor.*
c) *Misalignment.*

IF AMPLIFIERS

POOR SENSITIVITY

a) *Defective transistor(s).*
b) *Open bypass capacitor.*
c) *Misalignment.*
d) *Excessive agc voltage.*

WHISTLES

a) *Misalignment.*
b) *Defective neutralizing components.*

DISTORTION

a) *Low or no agc voltage.*
b) *Low battery voltage.*
c) *Defective transistor(s).*

NOISE

a) *Defective transistor(s).*
b) *Corroded solder connections in if transformer.*

MOTORBOATING

a) *Misalignment.*
b) *Open decoupling capacitor.*
c) *Weak battery.*

SQUEALS

a) *Misalignment.*
b) *Open decoupling capacitor.*

DETECTOR
(DIODE OR TRANSISTOR)

WEAK SIGNAL

a) *Defective rf bypass capacitor.*
b) *Misalignment.*
c) *Defective diode or transistor.*

NO AGC VOLTAGE

a) *Defective diode.*
b) *Defective transistor.*
c) *Shorted rf bypass capacitor.*
d) *Shorted agc filter capacitor.*

DISTORTION

a) *Shorted af coupling capacitor.*
b) *Shorted agc filter capacitor.*
c) *Defective diode or transistor.*

AUDIO DRIVER

LOW AUDIO OUTPUT

a) *Open emitter bypass capacitor.*
b) *Defective transistor.*

MOTORBOATING

a) *Open decoupling capacitor.*
b) *Open supply filter capacitor.*

DISTORTION

a) *Shorted emitter bypass capacitor.*
b) *Defective transistor.*

AUDIO OUTPUT STAGE
(CLASS A OR B)

LOW OUTPUT

a) *Open emitter bypass capacitor.*
b) *Defective speaker.*
c) *Defective transistor.*

MOTORBOATING

a) *Open supply filter capacitor.*
b) *Open decoupling capacitor.*
c) *Change in value of feedback resistor.*

DISTORTION

a) *Defective speaker.*
b) *Shorted emitter bypass capacitor.*
c) *Shorted primary turns in output transformer.*
d) *Defective transistor.*

REFLEX IF AMPLIFIER

WEAK SIGNAL

a) *Open base bypass capacitor.*
b) *Open emitter bypass capacitor.*
c) *Open rf choke.*
d) *Defective af coupling.*
e) *Defective transistor.*

DISTORTION

a) *Shorted af coupling capacitor.*
b) *Shorted emitter bypass capacitor.*

GENERAL

NOISE

a) *Dirty volume control.*
b) *Dirty tuning capacitor.*
c) *Leaky electrolytic capacitor.*

SHORT BATTERY LIFE

a) *Defective switch.*
b) *Shorted or leaky supply filter capacitor.*
c) *Defective transistor.*

DRIFT

a) *Weak battery.*
b) *Defective oscillator transistor.*

FADES

a) *Weak battery.*
b) *Defective transistor.*

INTERMITTENT

a) *Dirty switch contacts.*
b) *Corroded battery terminal.*
c) *Poor solder connections.*
d) *Dirty tuning capacitor.*

BUILD

ELECTRONIC SHOOTING GALLERY

Practice shooting at home—with a light beam

By R. E. PITTET, JR.

MANY TYPES OF SHOOTING GALLERIES use a light beam, photocell and relay. Most require a target connected to a 117-volt ac outlet. This restricts target placement and presents a possible shock hazard. This shooting gallery avoids these two disadvantages by featuring a transistorized portable, battery-operated target mechanism.

The gun is an inexpensive plastic water pistol modified to hold the switch mechanism coupled to its trigger, the light bulb and a simple optical system. Its power supply is external. The gun fires a bullet of light of short duration, so the shooter can't move the light beam onto the bull's-eye after pulling the trigger. Hits are registered by a flash of light from a small indicator lamp mounted on the target or a bell or buzzer.

The target is compact. Its working components are mounted on a 2¼ x 2¼-inch piece of perforated phenolic board. Just below the board is a ⅞-inch diameter black cardboard tube 2¾ inches long. A B-2M photocell is fastened to the back of the tube. The other end fits into a hole on the target. As you have probably guessed, this is the bull's-eye and a 2¾-inch focal-length lens is mounted here.

Construction details

Obtain a small plastic pistol and assemble the optical system. Use some fast-drying cement to mount a ⅜-inch-diameter 2-inch focal-length lens on the end of a ¾ x 3½-inch aluminum or plastic strip. Then place a lighted lamp on the other end of the strip. Point the assembly toward a wall about 10 feet away and move the lamp back and forth until it focuses sharply on the wall. Fasten the lamp holder in place at this point (Fig. 1).

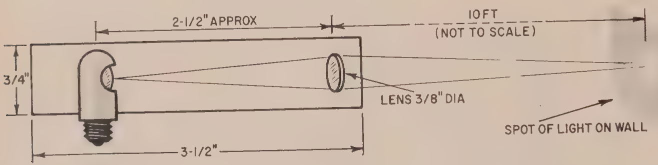


Fig. 1—Optical assembly for the pistol.

Now paint the assembly and the water pistol's interior with a flat black paint. When dry, mount it in the gun. With the lamp lit, mount some plastic sights on the top of the barrel and line them up with the beam of light focused on a surface some 10 feet distant. If this is done accurately, target shooting will be very realistic and become a game that requires real skill.

The next step is to couple a single-pole double-throw switching arrangement to the trigger (Fig. 2). A good way to build this is with three small strips of brass. Solder the leads to the brass strips and then glue the strips to the inside of the plastic pistol so the pistol trigger will move the center strip from contact with one strip to contact with the other. When this is set up, reassemble the gun and connect the leads from the switch through a cable to the battery–capacitor arrangement as in Fig. 2.

The target also has an optical system, mounted in a cardboard tube. To determine the proper distance between the lens and the B-2M photocell, hold the lens and focus the light from a

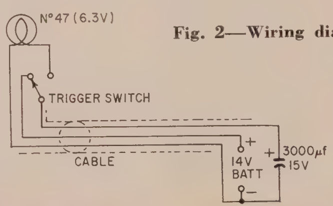
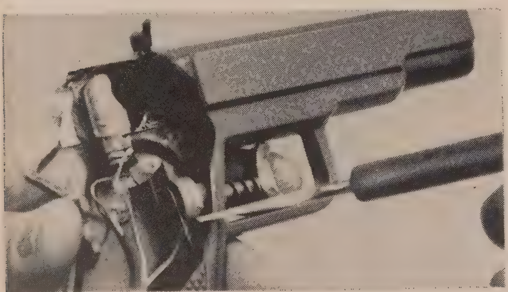
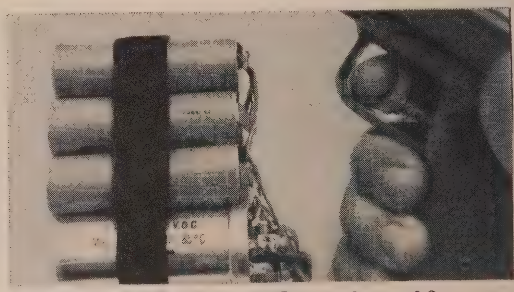


Fig. 2—Wiring diagram for the pistol.

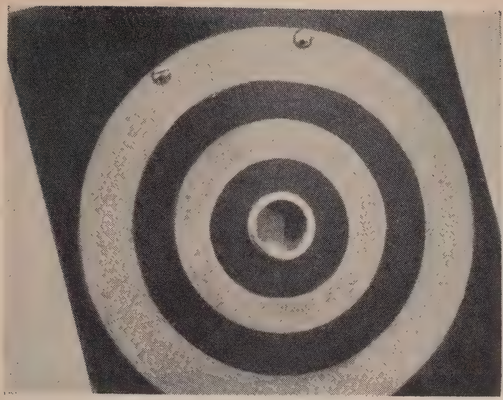
Lamp, 6.3 volts, No. 47
Battery, 14 volts (two 5-volt mercury batteries, and one 4-volt battery in series)
Switch, see text for instructions
Capacitor, 3000 µf, 15 volts
Aluminum or plastic strip, ¾ x 3½ x 1/16 inch
Plastic pistol
Lens (Edmund Scientific Co., Barrington, N. J., beginners lens kit No. 2)



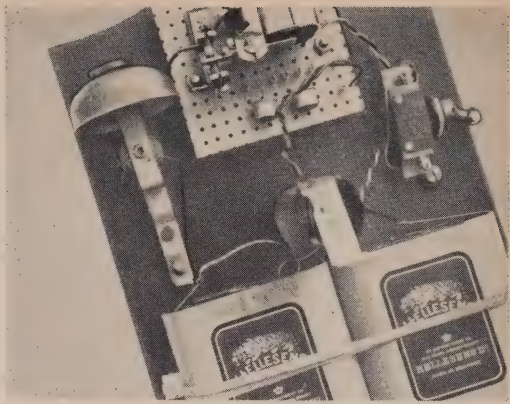
The electrical assembly mounted in the pistol.



Pistol power supply is external. It is made up of 3 mercury batteries and a high-value electrolytic capacitor.



Close-up of the target. Lens is mounted in the bullseye.



Electronic portion of the target. This one uses a bell to indicate hits.

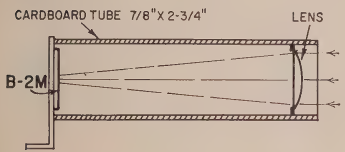


Fig. 3—Simple optical assembly used at the target.

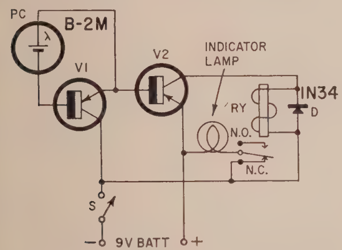


Fig. 4—Target circuit uses two transistors.

Photocell, B-2M (International Rectifier)
Transistors, p-n-p (almost any type)
Relay, Sigma 4F
Diode, 1N34
Switch, spst toggle
Battery, 9 volts
Lens (Edmund Scientific Co., Barrington, N. J., beginners lens kit No. 2) (One kit will supply all lenses for this project.)
Cardboard tube, ⅞-inch diameter, 2¾ inches long

bright window or ceiling lamp on a piece of white paper. At the proper focus point, you will see an image of the window or lamp on the paper. Measure the distance between the lens and paper at this point. This distance is used when setting up the target optical system (Fig. 3).

The direct-coupled transistor amplifier requires no resistors or capacitors. The diode is inserted only to prevent the collapsing field built up by the relay winding from injuring the transistors. I used some 29-cent p-n-p bargain-basement transistors and almost any p-n-p units will work (Fig. 4).

Unlike most photoelectric circuits, this one draws current when idle and cuts off when light strikes the photocell. But since current drain is only 2 ma, the batteries last quite a while.

Set the target relay to pull in at about 1.4 ma and release at 0.8 ma. Some trial adjustments will be necessary before the target responds properly. However, once it is set, you should have no further trouble.

Final comments

Once the unit is set up, there is little that can go wrong. It will work at distances up to 15 feet, although the pistol must be kept steady.

The battery which powers the transistor amplifier also powers the target-hit indicator. To prolong battery life, it is best to use separate batteries to power the indicator—a small one for the transistor circuit and a large one for the indicator.

Although the battery voltage for the lamp in the pistol is twice the lamp rating, don't worry. The capacitor discharges rapidly and peak voltage is maintained for only a very brief instant each time the trigger is pulled.

Good shooting! END

Snow in the IF?

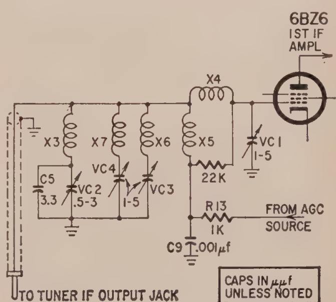
YES, IT CAN HAPPEN HERE. WE USUALLY think of snow as a tuner trouble, but an if can be the culprit. I learned this dramatically from a Philco chassis 11N51. The picture was fair, but the customer complained of snow. He said it had been that way since it was new.

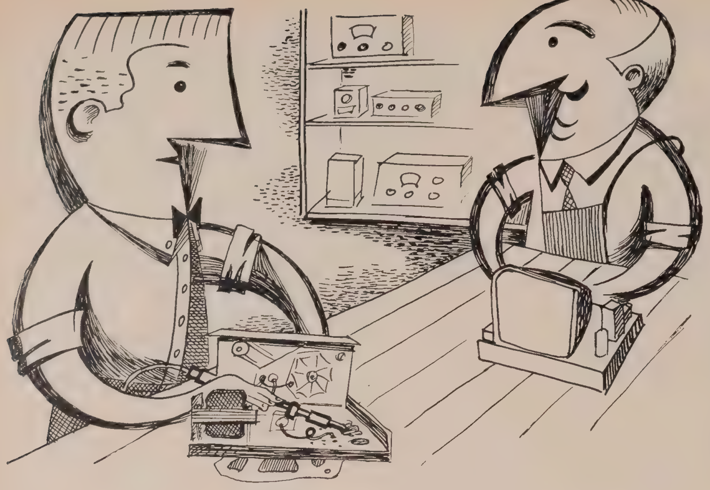
We checked the tuner agc. It was about 4 volts negative. We tried bypassing the antenna transformer with a small capacitor. The agc did not increase. We grounded the agc to the tuner. The picture overloaded and began to bend—but it was still snowy! This was our first clue that we must have overloading in the if's. Next we tried a quick check with a vtvm at the if agc terminal. The if agc was zero!

We measured the agc line with an ohmmeter. There was a 3,000-ohm short going back toward the first if stage. A look at the schematic showed that the agc voltage was fed only to the first if stage directly. The resistance to ground on the C9 side of R13 was about 2,000 ohms. Capacitor C9, VC3, VC4, VC2, VC1 or C5 could be leaky. We opened the circuit between X7 and X6. The short was in the tuner direction, but none of the remaining capacitors were leaky!

What was the trouble? Evidently when the set was manufactured, the cable from the tuner had been heated fairly hot and a carbon (or chemical) trail had been deposited across its terminals, leaving an approximate 2,000-ohm leakage. It killed the agc and greatly reduced the tuner output. Turned out that all we had to do was reheat the terminals! The leakage disappeared, and needless to say, so did the snow!

Snow had been caused by the if stage running wide open with a reduced signal input!—*Mike Wayne*





THE OLD-TIMER Helps Replace a Power Transformer

By JACK DARR
SERVICE EDITOR

PART II:—The Young Ham finishes up the power transformer installation with an assist or two from the Old Timer

GUESS it's time to get back to that transformer," said the Young Ham.

"OK, I was goin' to get to that subject anyhow," replied the Old-Timer. "Now, let's git that mess off of there and see where we are." The Young Ham picked up a soldering iron and started to disconnect the old wiring.

After unsoldering, he took out the bolts and pried the old transformer loose from the chassis. "Here," said the Old-Timer. "Scrape off as much of that old burnt wax and potting compound as you can, then kinda wash the chassis off with this solvent. This is the stuff cleaners use and it'll cut that gunk. If you don't the thing'll stink so bad when it warms up you'll think it's burning out again."

The Young Ham scrubbed industriously at the chassis. When he had it clean enough for the Old-Timer's satisfaction, he took the new transformer out of its box. His face fell. "Aww, shucks," he said. "It's the wrong kind!"

The Old-Timer ambled over and looked at it. "Be not dismayed," he said. "This is easily fixed. It'll mount there easy as pie. Look ye, youngling, there's only two kinds of transformer housings. There's the 'upright' like this one, and there's th' 'half-shell' like this one (Fig. 1). There's variations of both of 'em, of course. Sometimes you'll find half-shells without th' bottom shell that this 'n's got, and you'll see uprights without any outside shells at all, and so on. But, you can always mount any of 'em, if you've got room on the chassis.

"I run into that kind of problem this morning. Old transformer was a little squarish potted deal, but I had a little half-shell that was just right. So I took the bolts out of it an' put in long ones an' bolted 'er down snug as a bug in a rug (Fig. 2). It fit all right, and I had plenty of clearance. You can do the same thing here, if you want to."

"OK," mumbled the Young Ham, as he set to work. The Old-Timer wandered back up to his own end of the bench and began working on a TV set. Presently the Young Ham finished the mounting, and exclaimed, "Oh, oh. Where's the box? Now, I don't know where all these wires go."

Where do we go from here

The Old-Timer came over to him. "Don't need to," he observed. "They're color-coded. Ain't you got a copy of th' code around here somewhere? Yeah, sure. There it is," and he pointed to a large chart of miscellaneous codes and tables tacked to the door (Fig. 3). "Standard color code for power transformers. Now, remember one thing: while you'll find practically all standard replacement transformers coded this way, don't depend on finding the original transformer coded to match! Sometimes the manufacturer made up his own color code as he went along, seems like. You just trace the connections out. That's easy to do: 5Y3 filament, pins 2 and 8; plates pins 4 and 6. Six-volt heater line, usually on pin 2 of the nearest 6-volt tube (one of th' 6V6's, in this case), t'other one to ground. High-voltage center tap to ground. Primary to th' switch and th' line cord, and so on. Find th' wires on this transformer according to th' color code, and awa-a-ay you go."

The Young Ham went busily to work, humming to himself. The Old-Timer grinned, and went back to his TV set. Presently, the Young Ham looked up and announced, "Well, there she is.

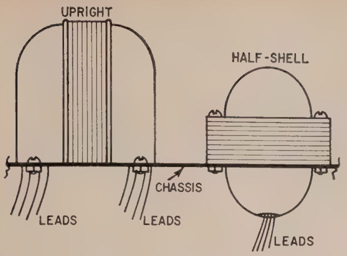


Fig. 1—Upright and half-shell power transformer mounting. Either type can be used to replace the other, if electrical characteristics are the same and there is enough room on the chassis.

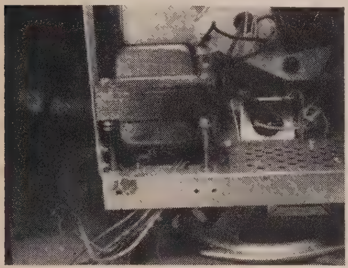


Fig. 2—How to mount a double half-shell transformer to replace an upright or a potted unit.

Want to take a look at it before I start the countdown?"

"Indood I dee," answered the Old-Timer, coming over to him. He inspected the chassis closely, checked the solder joints, and presently agreed that it was all right. The Young Ham beamed. The Old-Timer took a second look at the chassis, grinned to himself, and said, "Well, I'm ready if you are. Now let's run a few careful tests. Remember, we don't know what took the old transformer out yet! So let's pro-ceed with extreme caution, as the feller says. All tubes still out? Good. Now, plug it in th' wattmeter and turn it on." The Young Ham did. The wattmeter needle swung just above zero, then returned to the pin. "Good!" said the Old-Timer. "That's what we oughta have. Y'see, a good transformer has practically no

Primary	Black
High-voltage secondary	Red
High-voltage secondary, ct	Red-yellow
5-volt filament	Yellow
5-volt filament, ct	Yellow-blue
1st 6.3-volt filament	Green
1st 6.3-volt filament, ct	Green-yellow
2nd 6.3-volt filament	Brown
2nd 6.3-volt filament, ct	Brown-yellow
3rd 6.3-volt filament	Slate
3rd 6.3-volt filament, ct	Slate-yellow

Fig. 3—Power transformer color-coding.

and announced, "Well, there she is. losses to speak of, runnin' 'no-load' like that, so you shouldn't see any current drain at all without the tubes. Now, pull it out." The Young Ham complied. "Now, even if you've already done it, measure from the rectifier cathode to chassis with a high range on the ohmmeter. Or, better still, with a 300-volt range on the capacitor checker, to see if we got any B-plus shorts." The Young Ham did, with no results.

"Good again. Now put th' tubes back in and we'll see wha' hoppens." The Young Ham did so.

"Hey, I don't see the rectifier!" he said. The Old-Timer handed him a new 5Y3 from the shelf-saying, "It's probably no good anyhow. Go ahead and use this one."

The speaker was silent

The Young Ham turned the amplifier on, after connecting the bench speaker to it. The wattmeter needle swung up to a reading of about 30 watts, but the speaker remained silent. The Young Ham looked puzzled. He picked up a voltmeter probe and measured the B-plus. "Hey! I got about 400 volts here!" he cried. "I thought that transformer only had about 300! No sound, either. Now, what's the matter with the darn thing?"

The Old-Timer grinned. "Well, whatever it is, it don't seem to be a short," he observed calmly. "You're only drawin' 30 watts. Look around, an' see if you can't find somethin' missin' that ought to be there."

The Young Ham measured all the plate voltages, and shook his head. "I don't get it at all," he said in bewilderment. "Looky! I've got 400 volts on all the plates, everywhere! What th' heck's goin' on here!"

The Old-Timer burst out laughing. "I'm sorry, Junior," he said. "I just couldn't help it. I saw what you'd done, but I've done it so many times myself that I jist couldn't resist lettin' you hunt for it a while. Try checkin' your *filament voltage!*"

The Young Ham did. "Hey! No filament! No wonder the thing had such high voltage! None of the tubes were drawing any current!"

"That's right," agreed the Old-Timer. "Now I'll show you why. You connected up the green wires, just like you should, didn't you? What did you do with the green-and-yellow wire, the center tap?"

"Cut it off and taped the end," said the Young Ham. "Why?"

"That's your trouble." The Old-Timer grinned. "Take that tape off an' take a look at them wires." The Young Ham did so.

"See what I mean? Those wires are double. The filament winding is heavy wire. When they made the center tap, they just brought out the ends of the wires, twisted a loop in 'em, cut and tinned the ends, and stuck that piece of heavy spaghetti over 'em. When you cut 'em off, you cut past the place where they were tinned. What you got there now is two 3.15-volt windings with one end hangin' open! (Fig. 4). Tin the ends and solder 'em together, and—

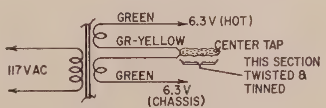


Fig. 4—Center-tapped 6.3-volt heater winding. Center tap is two leads. If you cut center tap short, be sure to solder leads together.

voilà!—you'll be right back in business!"

The Young Ham did this, replaced the tape, and once more turned the amplifier on. This time, the wattmeter rose to about 30 watts, hesitated, then kept on climbing until a reading of about 60 watts was reached. "That's more like it," said the Old-Timer, as a low hum came from the speaker. "Touch the input grid there." The Young Ham did so, and was rewarded with a loud squawk from the speaker. "Now! Now we're gittin' somewhere," remarked the Old-Timer. "Let 'er cook there for about an hour, and you're all done."

What made it blow?

The Old-Timer leaned back on his stool, with his hands locked around his knee. "Only one thing worries me," he said. "What made that transformer blow in the first place? You see, there's only two things that can burn out a transformer, and they're both overloads. One, of course, is an external overload like a shorted filter capacitor, and the other is an internal short. For instance, if the insulation broke down on a couple of turns of wire anywhere in that transformer, that's a 'shorted turn' and the current would build up somethin' scandalous in it. It'd git red hot and cause the turns on either side to break down, too, and it's just Katie bar th' door for th' poor li'l transformer. That musta been what happened to that one. Whatcha got there?"

The Young Ham had picked up a tube which had rolled behind some stuff

Fig. 5—The guilty 5Y3, with glass removed to show the melted parts.

on his end of the bench.

"I'll bet you this was the rectifier tube out of that thing!" he cried. "Gollee, look at it! What in the world happened to it?" He handed it to the Old-Timer, who looked at it and whistled. "Phee-yew! No wonder th' poor little transformer fell all to pieces! See what happened, don't you? The filament broke in two and fell over into th' plates. That started a big fat arc, and she just sat there and melted herself down into a cute little puddle! I don't believe I ever saw one melt down that good before (Fig. 5)! Well, that's just another darn good reason for usin' a line fuse. That thing hasn't got one on it, has it? Gosh, no!" He answered his own question. "You can see it ain't, from the shape this and th' transformer's in. Well, it'll have one when it leaves here! Is there enough room

on that chassis to put a fuse post there?"

"I don't think so," answered the Young Ham, doubtfully. "It's pretty crowded under there."

"Well, anyhow, this is a lot easier to install. Here," and he reached in a drawer and tossed the Young Ham a large line plug, "that'll do just as well. It's a fusible plug (Fig. 6). You put it on in place of the regular line plug, and put two 1-amp fuses in it, one in each side. There's a whole bunch of different kinds of those, and every amplifier or anything else with a power transformer sure ought to have one! You can buy a heck of a lot of fuses for what one power transformer costs! One thing you wanta check, though—whenever you see one of 'em, look and see if some knucklehead hasn't put a 20-amp auto fuse in it instead of the 1-amp it oughta have!"

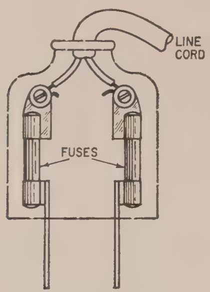


Fig. 6—View of typical fused plug for use with equipment that does not have built-in fuse protection. It is installed in place of the regular line plug.

"That's a good idea, all right," agreed the Young Ham. "I believe I'll put one of those on the power supply of my new transmitter!"

"Well, whenever you replace a power transformer in *anything* around here, be sure it either has its own line fuse or one of these on it before it leaves this shop!" declared the Old-Timer firmly. "That sure saves a lot of trouble! Also, be sure to cook that thing as long as you can before the customer comes after it. All day, if you get the time. That way, if anything else is on the verge of going bad, like a weak filter capacitor or something, you've got a fair chance of catching it before it's delivered. Good reason for it too. If this poor guy has just chumped off $18 or $20 bucks to get the thing fixed, he's going to be a little tender around the pocketbook for a few days, and for some reason he's gonna expect th' thing to work! If it goes phoop on him, he's liable to come down here and mop up the place with both of us! And, saaay, you know, speakin' of moppin' up—" He glanced meaningfully around the shop. The Young Ham sprang from his stool, crying, "Quittin' time! Quittin' time!" and dashed off across the shop with the Old-Timer in hot pursuit. The clock on the wall said 4:30! END

DX SHORT-WAVE FORECAST

Nov. 15–Dec. 15 **By STANLEY LEINWOLL†**

Most readers are probably familiar with the International Geophysical Year (IGY), the recent program in which scientists from 66 countries cooperated in a joint effort to further man's knowledge of the world in which we live.

This program was so successful that plans are now being made to conduct a "little IGY" during the coming years of *minimum* sunspot activity. Preliminary details were worked out at a recent meeting in Paris of the International Committee on Geophysics, and the name International Year of the Quiet Sun (IQSY) was officially adopted.

The IQSY will begin in the spring of 1964 and continue through the winter of 1965. Information about the sun, sunspots, the ionosphere and auroras will again be gathered by scientists throughout the world, using the latest available techniques, which will include high-energy radio waves, rockets and satellites.

The IGY studies yielded a wealth of valuable information about the earth and its atmosphere, and it is anticipated that the IQSY will yield further useful data in man's continuing quest for knowledge about his environment.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated. For example, a listener in Pittsburgh, Pa. would use the Eastern USA table. He would be most likely to hear broadcasts from West Europe in the 21-mc band at noon, and the 9-mc band at 8 p.m., Eastern Standard Time. However, day-to-day variations in receiving conditions can be large.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, *in your local standard time.)* The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

EASTERN US to:

	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6	6	6	9*	21	21	21	17	11	9	9	6
East Europe	7	7*	6*	9*	21	21	17	11	9	7	7	7
Northern Latin America	11	9	9	11	15	17	15	17	17	15	11	11
Southern Latin America	11	11	9	11	15	15	15*	17	17	15	11	11
Near East	7	7	6*	11*	17	17	17	11	11	11	9	7
North Africa	7	7	7	11*	17	17	15	15	11	11	9	9
South & Central Africa	9	9	7*	17	21	21	21	15	11	11	11	11
Far East	11	9	9	7	9	7*	9*	7*	9*	15	15	11
Australia & New Zealand	11	11	9	9	11	11	15*	15	15	17	17	11

WESTERN US to:

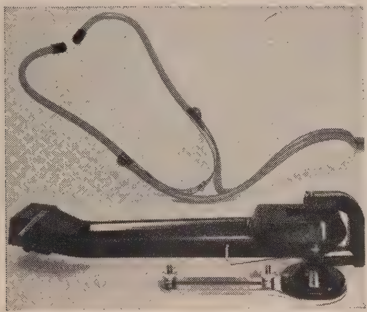
	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6*	7	7*	11*	17	17	15	9	7	6	6	6*
East Europe	7	7	7*	7*	11	15	15	9	9	7	7	7
Northern Latin America	9	9	9	9	15	15	15	17	17	15	11	11
Southern Latin America	11	9	9	11	15	15*	17	17	17	15	11	11
North Africa	9	7	7	11	17	17	15	9	9	9	7	7
South & Central Africa	9	9	9*	15	21	21	21	15	15	11	11	11
Far East	7	7	7	7	7	9	9	17	17	17	15	9
South Asia	7	7	7	7	9	15	11	11*	15	15	15	9
Australia & New Zealand	11	11	9	7	11	11	15	15	21	21	17	15

CENTRAL US to:

	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6	7*	7*	9*	21	21	17	11	9*	7	6	6
East Europe	7	7	7*	9*	15	11	9*	9*	9	9	7	7
Northern Latin America	11	9	9	15	17	17	15	17	17	15	11	11
Southern Latin America	11	9	9	15	15	17	17	17	17	15	11	11
Near East	9	7*	7*	9*	17	15	11	9	9	9	7	7
North Africa	7	7	7*	7*	17	17	17	11	9	9	9	7
South & Central Africa	9	9	9*	17	21	21	21	17	15	11	11	9
Far East	7*	7*	7	7	9	9	7*	9*	21	21	11	9
Australia & New Zealand	11	11	9	9	11	11	15*	15	17	17	15	11

†Radio-frequency and propagation manager, RADIO FREE EUROPE.
*Reception may be very poor or impossible on this path at this hour.

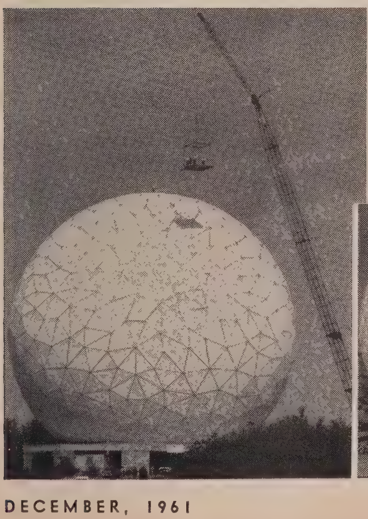
What's New

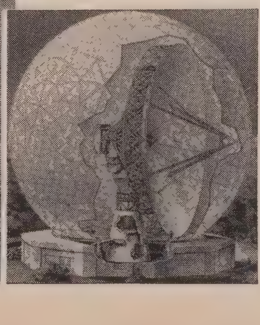


YOU HEAR STEREO WITHOUT ELECTRONICS when you listen to stereo records with this pickup arm. The cartridge produces audible sound which is fed through two tubes, one in each branch of the arm, and on to the headset (rear) through a length of hollow tubing. The device has individual volume controls and a blend control. The Sterephone is made in Japan and distributed in the US by Trans-National Pioneer.

NUCLEAR THERMOELECTRIC POWER system will deliver 50--60 watts of electricity for three months on the moon's surface. The system, developed by Westinghouse, uses the spontaneous decay of a radio-isotope to produce heat which is converted into electricity by a thermoelectric system. The curved sheets at either side are waste heat radiators. A model of the system is shown here.

BUG-EYED DEVICE measures blood circulation through the eye cavity and, by inference, blood circulation to and from the brain. The Decker Corporation makes this Ophthalmic Artery Pulsensor which delivers valuable information on vision defects and damage to the circulatory system of the brain.

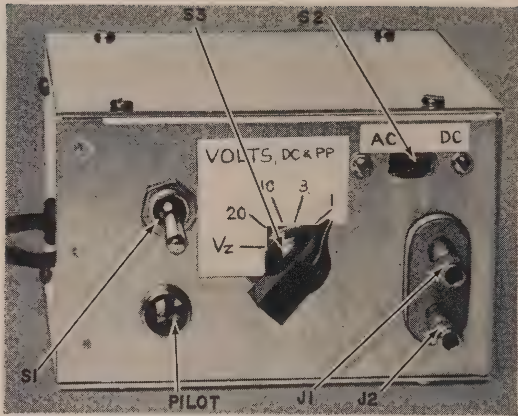




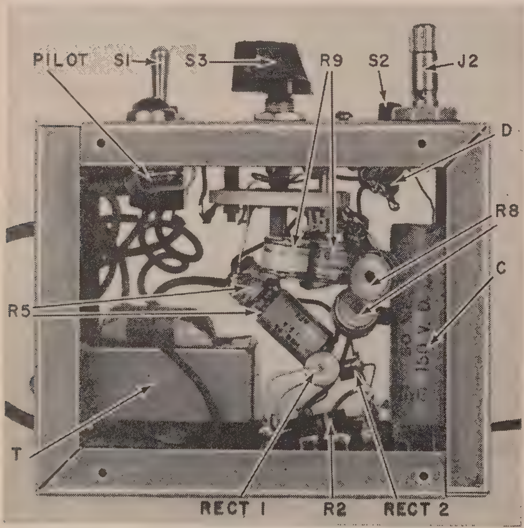
WORLD'S LARGEST RADOME, a 150-foot wide sphere, has been set up on Haystack Hill, Tyngsboro, Mass. It will house a sensitive precise 120-foot parabolic antenna (described in the October issue, page 12) for radio communications and space research. The radome was designed by Lincoln Laboratory of MIT and built by the H. I. Thompson Fiber Glass Co. under the direction of the Air Force's Electronic Systems Division.

ZENER DIODE voltage calibrator

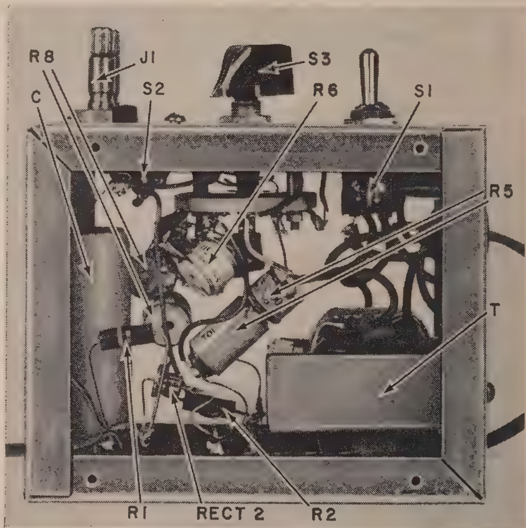
If your vtvm and scope are accurate, your measurements will be correct. You can calibrate both precisely with this simple instrument



Front panel of the completed unit.



Inside the calibrator; view from the bottom.



Inside the calibrator; view from the top.

By PAUL S. LEDERER

This calibrator produces dc voltages of 1, 3, 10 and 20 volts, and positive-going 60-cycle square waves of 1, 3, 10 and 20 volts peak to peak. The amplitude of these voltages is accurate within 3% and is constant within better than 1% for line voltages between 105 and 125.

The heart of the device is a Zener diode semiconductor voltage regulator. In its forward direction, it acts like a conventional silicon rectifier. Similarly, it will show a high resistance in the reverse direction for voltages up to a critical value. At that point, the Zener voltage, the diode breaks down and current flows through it in the reverse direction. Once reverse current flows through the diode, the voltage across it will remain constant over a wide range of current. Thus the Zener diode acts as a voltage regulator. Standard commercial units are available for voltages from about 4 to 100.

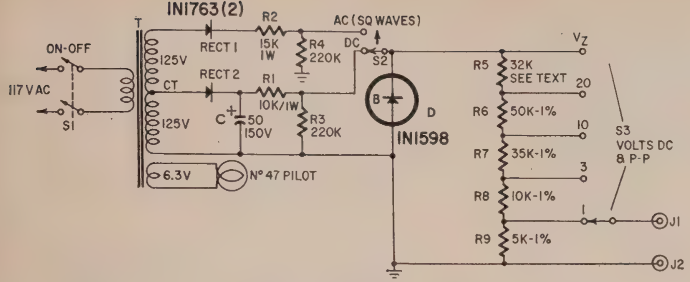
To obtain accurately known dc voltages, we feed voltage to the diode through a resistor. Variations in supply voltage will cause the current through the Zener diode to vary. But as long as the current is within the Zener region, the voltage drop across the diode (Zener voltage) remains essentially unchanged.

By putting a resistive voltage divider across the Zener diode, a number of voltages can be derived. To calibrate vtvm's, it seemed desirable to have 1, 3, 10 and 20 volts. A (nominal) 27-volt 3.5-watt Zener diode was selected. This high-power type Zener diode was chosen to minimize voltage variations caused by self-heating.

Since most scopes do not have dc amplifiers, we must use ac to determine deflection sensitivity. This calibrator produces 60-cycle square waves. They are generated by a refined version of a scheme I described in the July 1958 issue of RADIO-ELECTRONICS, page 76.

How it works

Ac from the high-voltage winding of a power transformer is fed to the Zener diode through a large series resistor



R1—10,000 ohms, 1 watt, 10%
R2—15,000 ohms, 1 watt, 10%
R3, R4—220,000 ohms, ½ watt, 10%
R5—see text, value varies with Zener diode used
R6—50,000 ohms, 1%, ½ watt
R7—35,000 ohms, 1%, ½ watt
R8—10,000 ohms, 1%, ½ watt
R9—5,000 ohms, 1%, ½ watt
C—50 µf, 150 volts electrolytic
D—1N1598 (IRC)
J1, J2—terminal posts
RECT 1, RECT 2—1N1763 (RCA)
S1—dpst toggle switch
S2—spdt slide switch
S3—single-pole 5-position rotary switch
T—power transformer: primary, 117 volts; secondary, 250 volts, 25 ma, ct; 6.3 volts, 1 amp (Stancor PS-8416 or equivalent)
Case, to suit
Miscellaneous hardware

Circuit of the accurate calibrator.

(see schematic). On the positive-going half of the cycle, voltage is applied to the diode in the reverse direction. When the positive-going voltage reaches the Zener value, the diode conducts in the reverse direction and the voltage across it remains constant at the Zener level as long as the applied ac amplitude remains above this level. During the negative half of the cycle, the diode conducts heavily in the forward direction and the voltage across it is almost zero. Thus we get positive-going square waves whose amplitude is set by the diode's Zener rating. Strictly speaking, they are not true square waves but "clipped sine waves" of trapezoidal shape. If the peak ac amplitude is about 10 times the Zener voltage, the waveshape will be that of an excellent square wave.

During the negative half of the cycle, the voltage across the Zener diode is actually near 1 volt, which would make the total square-wave amplitude higher than the value of Zener voltage. This is eliminated by placing a silicon rectifier (RECT 1, 1N1763) in series with the dropping resistor and Zener diode. It has no particular effect on the positive half of the cycle but, during the negative half, the back resistance of the diode is very high, more than a megohm. Consequently, most of the negative-half voltage appears across this rectifier, leaving only about 20 mv across the Zener and assuring a square-wave amplitude of precisely the Zener value.

A center-tapped 250-volt power transformer, with one end of the winding grounded, feeds 125 volts from its center tap through RECT 2 (1N1763), to supply filtered dc to the Zener diode. The other end of the winding supplies 250 volts ac through RECT 1.

A string of precision 1% resistors divides the Zener voltage down to 1, 3, 10 and 20. R5 is selected so that a previously calibrated precision vtvm reads exactly 10 volts when connected to the 10-volt output. Slide switch S2 selects dc or ac square-wave output.

The calibrator can also be used to adjust vtvm's since *in a square wave the average, rms and peak values are all the same.*

There are two common types of ac vtvm—those in which the indication is proportional to the average value of the rectified cycle of the applied waveform and those in which the indication is proportional to the positive peak value. Both types are generally factory-calibrated in terms of the *rms value* of a pure sine wave (which is 1.11 times the average value of this sine wave or 0.707 times the positive peak value of the sine wave).

The square wave of the calibrator goes from zero to the Zener voltage. This then is its peak-to-peak value.

When coupled through the blocking capacitor of an ac vtvm, the meter sees this as a square wave going above and below the zero reference, with a positive peak value exactly half that of the peak-to-peak or dc value. When this is applied to an average-reading ac vtvm, one would expect the meter to indicate 1.11 times the average value (which is the same as the peak value of this square wave).

A commercial ac vtvm of the average-reading type indicated 10.7 volts when connected to the 20-volt peak-to-peak output tap with switch S2 set to ac. A peak-reading ac vtvm indicated 7.8 volts for the same setting (not quite the expected 7.07-volt value, calling for readjustment of that meter). END

References

Paul S. Lederer, "Add an Amplitude Calibrator to Your Scope," RADIO-ELECTRONICS, July 1958

Zener Diode Handbook, International Rectifier Corp.

"Some Effects of Waveform on Vtvm Readings", *Hewlett-Packard Journal*, Vol. 6, Nos. 8, 9, 10, 1955.

Constant-setting audio volume control

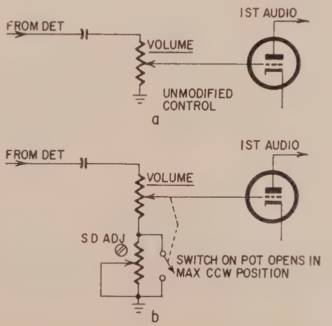
By RONALD L. IVES

IN MANY COMMERCIAL INSTALLATIONS the audio outputs of various receivers are transmitted to speakers in various locations. Each speaker, at the better installations, has its own volume control to set the audio level for that particular location.

All too often this logical system is disrupted by someone adjusting the volume on the main receiver. Then all speaker volume levels must be readjusted. This sometimes occurs several times during a working shift.

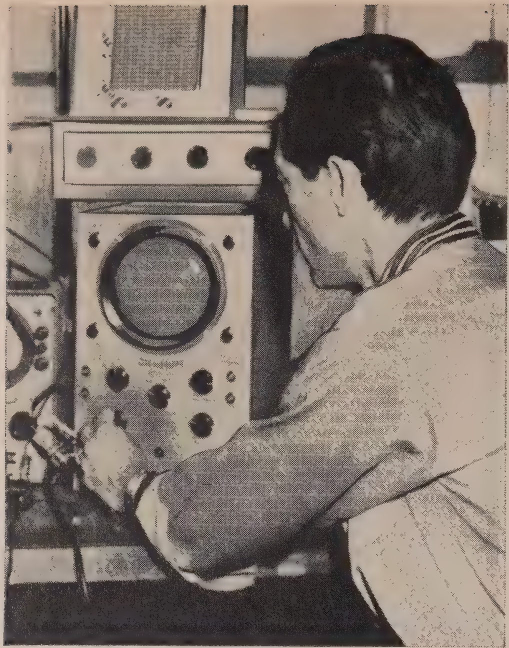
This recurrent annoyance can be eliminated by modifying the audio volume-control circuit slightly. A conventional audio volume-control circuit is shown at *a* in the diagram. The modification, requiring only an additional switch and variable resistor, is shown at *b*.

This is how the modified control works: When the knob is in any position other than OFF (extreme counterclockwise), the control functions normally and exactly as before the



modification. When the modified volume control is turned OFF (extreme counterclockwise), the switch opens. The volume-control circuit then becomes substantially a fixed divider, with the main volume-control potentiometer forming the upper leg and the added variable resistor (screwdriver-adjusted, inside chassis) the lower.

With this arrangement, when the speaker is feeding the lines to remote speakers, the main control is set at OFF position and the volume controls on the individual speakers regulate individual audio outputs. When the receiver is being used for other purposes, and the lines are not in use, the central volume control is used in the conventional manner. Unauthorized use of the main volume control may be prevented by a warning sign or locking device or by removing the knob, whichever may be convenient or necessary. END



FULL VALUE FROM YOUR SCOPE

Learn to take advantage of all the capabilities of your most useful instrument

By BARRON KEMP

THE OSCILLOSCOPE CAN PORTRAY INSTANTANEOUSLY the fluctuating circuit conditions in that dog you've got on the bench. You can use it to troubleshoot where multimeters and signal generators are stymied. A multimeter is ordinarily the ideal instrument for locating troubles such as incorrect or no voltage, short or open circuits. For other troubles, using a scope is often the easiest way to locate the bad stage. For example, hum or distortion in a receiver or amplifier output can be located quickly by connecting a scope to various points in the circuit. In the same manner, an open bypass capacitor is given away when you find a signal voltage where it shouldn't be. An example of this is at the screen grid of an amplifier where a capacitor bypasses the signal to cathode or ground. If the scope shows the signal voltage at the screen grid, there is no bypass action and the screen bypass capacitor is probably open.

A scope also helps when checking a power supply filter for open capacitors or ripple. It checks the gain of a stage by indicating the increase in signal amplitude from the grid to the plate circuit. It checks vibrator power supplies for correct output waveform, and multivibrator and blocking oscillator circuits where nonsinusoidal waveforms are involved. In addition, the scope is useful for determining frequency ratios by means of Lissajous figures, checking frequency response or phase shift in audio amplifiers, and checking the percentage of modulation in transmitters.

Your oscilloscope is a complicated instrument. Become familiar with it before using it so you'll use it properly and safely. The best way to do this is to read the manual on it and *think* before twisting knobs.

Never leave the brightness turned up when there is no sweep voltage. That single spot of light will burn the phosphor and ruin the CRT. Generally, scopes are used with the internal horizontal sweep operating, but some tests call for sweep off and external voltages applied to both horizontal and vertical inputs. To be safe, turn down the brightness level until the signal voltages have been applied to the inputs, then turn up the brightness just far enough to see the pattern clearly.

Avoid placing the scope where light falls directly on the face of the CRT. This will require increasing the brightness so you can see the trace despite the surrounding light. The higher the brightness level, the shorter the life of the CRT. If necessary, use a shield to block out surrounding light so that the brightness level can be kept low.

Keep the scope away from strong magnetic fields. They can distort the image on the CRT or magnetize the scope case. If this happens, the scope may be permanently inaccurate, even after it's removed from the source of magnetism.

Using your scope

It's good practice to set the horizontal frequency control so at least two cycles of the waveform appear on the screen. Also, you may find that your scope produces an inverted image because it has a different number of amplifier stages than other scopes. This is no handicap when examining sine waves or other symmetrical waveforms. However, when doing alignment work with a sweep generator, the required response curve will appear inverted on the screen of some scopes.

Another characteristic which may vary from one scope to another is the direction of the slope of the trace for comparison of in-phase and out-of-phase signals. This can be checked easily by

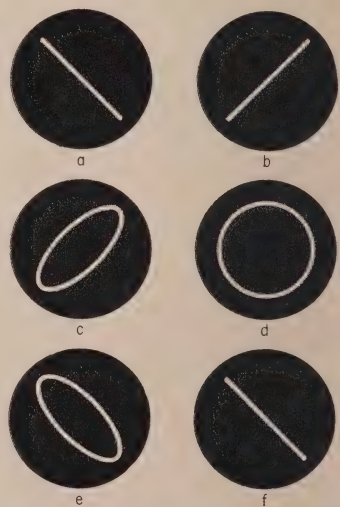


Fig. 1—Phase-angle patterns. Signal amplitudes, vertical and horizontal inputs are equal.

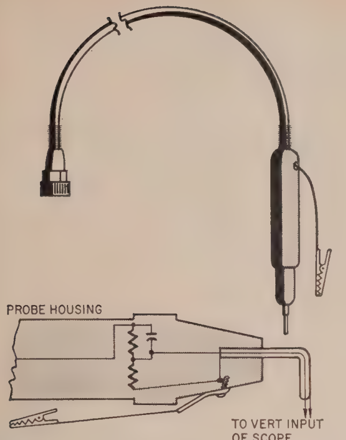


Fig. 2 — Oscilloscope voltage-divider probe.

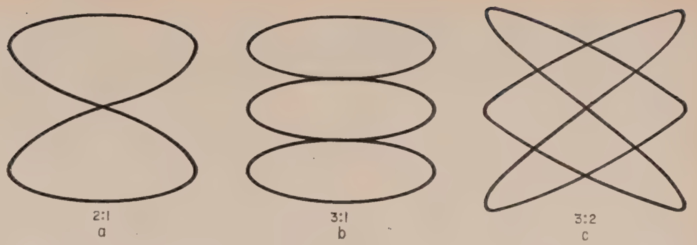


Fig. 3—Lissajous figures for frequency ratios. a—2 to 1. b—3 to 1. c—3 to 2.

applying the same signal to both vertical and horizontal terminals with the internal sweep turned off. (The signal source can be a 60-cycle voltage taken from the test terminals on the front panel of the scope or from the secondary of a filament transformer.) The trace will slope either to the right or to the left and represents the in-phase condition. If the trace slopes to the left (Fig. 1-a), signals 180° out of phase produce a trace sloping to the right (Fig. 1-b). When two signals of equal amplitude and frequency are compared, Fig. 1-c indicates a 45° phase shift; Fig. 1-d, a 90° phase shift; Fig. 1-e, a 135° phase shift; Figs. 1-e and -f, signals of opposite polarity or with an 180° phase shift between them. If the test described for the in-phase condition shows a pattern like Fig. 1-f, then Fig. 1-e would indicate 45°; Fig. 1-d, still 90°, Fig. 1-c, 135°, and Fig. 1-a, 180°.

Misleading information is sometimes presented on the CRT because of interference from external sources. Connect the scope to a ground point on the equipment you're testing. Be careful that the stray electric fields do not come close to the CRT. Such fields can also be picked up through your body as you handle the test leads. The condition becomes more troublesome when examining low-level signals with the gain of the scope amplifiers near maximum. To minimize the effects of such stray electric fields, avoid holding the test leads. Instead, clip them into the circuit and then examine the pattern. Avoid using too much gain and keep the input signal low, or overloading may distort the waveform.

Sometimes it's necessary to use a voltage-divider probe like the one shown in Fig. 2. It prevents overloading the oscilloscope amplifiers with high input-signal voltages. The probe cuts down the signal by a known amount so a true evaluation of signal amplitude is possible. The probe also isolates the scope from the circuit you're testing for minimum circuit loading. Capacitive loading can be minimized by adding a resistor in series with the hot test lead if you don't have a probe.

Measuring frequency

One important function of your scope is measuring frequency. When two sine-wave voltages are applied to the scope's deflection system, one to the vertical input and the other to the horizontal input, the resultant pattern is called a Lissajous figure. Fig. 3 shows three Lissajous figures for ratios commonly encountered in frequency measurement. The ratio of the two frequencies can be determined by counting the number of loops along the right and top edges and substituting the results in the formula:

$$\frac{\text{frequency on horizontal axis}}{\text{frequency on vertical axis}} = \frac{\text{number of loops on right (or left) edge}}{\text{number of loops on top (or bottom) edge}}$$

If the frequency of one signal is known, the frequency of the other signal can be easily determined from the frequency ratio. Usually the known signal is applied to the horizontal channel and the unknown signal to the vertical channel. The shape of the pattern changes with the phase relationship between the known and unknown relationship.

Accuracy of this method is limited to the accuracy of the known frequency. These patterns sometimes change because of slight deviations in phase and frequency between the reference and the signal under test. Pattern drift and the consequent difficulty in counting limit this method of frequency measurement to a practical ratio of 10 to 1. However, if extreme care is taken in counting and if the gain of the scope is increased, it is possible to count as many as 30 loops.

Square-wave testing

You can use the scope and a square-wave generator to check frequency response, phase shift and transient response of an amplifier by using the arrangement shown in Fig. 4-a.

First, the square-wave output of the generator is viewed on the scope. Adjust the horizontal sweep so at least two full cycles can be seen on the screen. Then connect the scope to the loaded output of the amplifier under test so that the modified square wave can be viewed on the screen for comparison with the unmodified output of the signal generator. Figs. 4-b through 4-j show possible output waveshapes.

Rounding of the leading edge of the square wave (Fig. 4-c) indicates a drop in gain at high frequencies. Such rounding is generally seen when there is a substantial drop in the gain by the tenth harmonic (or less). So if a 2-kc square wave is reproduced on the scope without rounding, the amplifier is flat to 10 × 2 kc, or 20 kc.

Fig. 4-d shows the effect of increased gain, and 4-e the effect of decreased gain at the square-wave frequency. Fig. 4-f indicates lowered gain at a narrow frequency band. If the square-wave frequency is brought into this narrow frequency band, Fig. 4-e results.

The result of phase shift in the

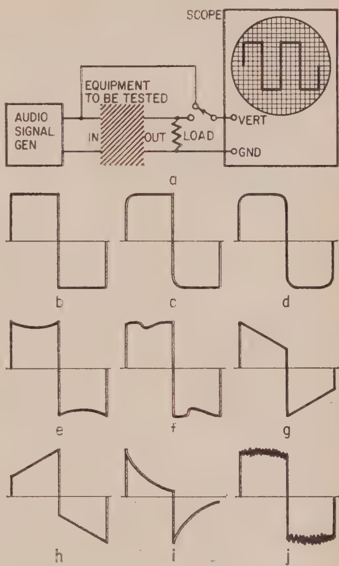


Fig. 4—Connections for square-wave testing of amplifiers; b to j—nine possible waveform distortions caused by amplifier circuit defects.

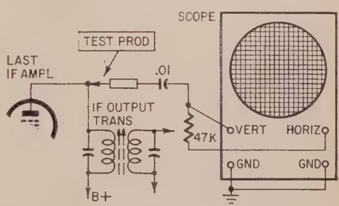


Fig. 5—Hookup for percentage of modulation measurement.

amplifier is shown in Figs. 4-g and 4-h. If, at low frequencies, there is phase shift in the leading direction, the top of the square wave will be tilted as in Fig. 4-h. The steepness of the tilt is proportional to the amount of phase shift. Although phase shift is not important in audio amplifiers, even though the ear is somewhat sensitive to it, it should not be tolerated in television and oscilloscope amplifiers.

Fig. 4-i shows the pulse output from the amplifier resulting when the square wave has been differentiated. This will happen when the value of the grid resistor or the coupling capacitor is low or if the coupling capacitor is too low or partially open.

Fig. 4-j shows a square wave with damped oscillations following the leading edge. This results when a high-frequency square wave is fed to an amplifier in which distributed capacitance and lead inductances resonate at low frequencies. In television and oscilloscope amplifiers, this can result from an undamped peaking coil.

You can give hi-fi audio amplifiers a rapid check by testing first with a square wave of fundamental frequency not less than three to four times the low-frequency limit of the amplifier (3-db points), then with a square wave of fundamental frequency between 1/100 to 1/10 of the high-frequency limit of the amplifier, depending upon how many harmonics are considered necessary to produce an acceptable version of a square waveform. Square waves of fundamental frequency from 40 to 60 and 1,000 to 2,000 cycles are usually used to cover the range up to 20,000 cycles.

To insure correct results, connect the proper load across the amplifier output terminals and use low-capacitance cable to connect the generator to the amplifier input. If the amplifier has a high-impedance input, use a 1-megohm isolating resistor between the generator and the amplifier, shunted by a .001-μf capacitor if there is capacitance at the amplifier input. Set the generator output to an ample value but do not overload the amplifier. Feed the square-wave signal to the amplifier input and connect the scope across the amplifier load. Use the internal linear sweep to observe the waveform. The tone controls have a marked effect on square-wave response, so set all tone controls to their flat position unless you definitely wish to observe their effect. Also remember low-fidelity and PA amplifiers will not reproduce the square waveform.

You can test video amplifiers in the same manner as audio amplifiers, but the test frequencies might be 60 cycles for the low end and 25 kc for the high.

Determining deflection polarity

Some patterns, such as a simple sine wave, may show a distorted upper or lower half. The trouble cannot be definitely traced to its source unless the input polarity of the scope is known. Therefore, turn off the horizontal sweep and reduce the intensity (to protect the screen from being burned) to the point where you can barely see the spot of light. Turn the focus control to a position that makes the spot as large as possible, and the vertical gain control to its maximum clockwise position.

Now connect short pieces of insulated wire to the vertical amplifier terminals. Touch the two leads momentarily and simultaneously to the terminals of a 4- or 6-volt battery. The spot will jump either up or down, then return slowly. It jumps because the battery charges the vertical input blocking capacitor, which then slowly discharges. Next, touch the wires together to discharge the capacitor completely. Reverse the connections to the vertical terminals and connect them to the battery. The spot will now jump in the opposite direction. Note the polarity of the battery that makes the spot jump up. If the negative side of the battery is connected to the hot terminal of the scope's vertical input and the positive terminal of the battery is grounded, the input polarity is negative. If the opposite is true, the scope has a positive input polarity.

Measuring modulation

The oscilloscope is widely used as an amplitude-modulation measuring instrument. Since it can present visual indications of the modulated output of AM transmitters, it is a fairly reliable instrument for detecting overmodulation and determining percentage of modulation. One method of measuring percentage of modulation uses a receiver tuned to the transmitter frequency. Connect the oscilloscope as shown in Fig. 5 and retune the if stage to compensate for the additional loading. The oscilloscope pattern of an unmodulated carrier is a flat ellipse (Fig. 6-a) resulting from the phase shift produced by the horizontal amplifier input capacitance and the 47,000-ohm resistor. This line broadens with modulation (Fig. 6-b). For 100% modulation, the unilluminated area center of the pattern decreases to zero. Overmodulation (Fig. 6-c) goes beyond this point and a bright spot appears in the center of the pattern. The percentage of modulation may be determined by the formula given in the illustration.

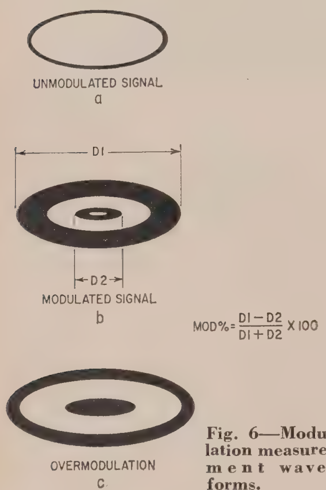


Fig. 6—Modulation measurement waveforms.

Trapezoidal modulation patterns may be obtained with the hookup in Fig. 7. The scope's vertical deflection plates are fed the if carrier from the plate of the if output stage, and the horizontal plates or amplifier is fed a small portion of the audio signal from the receiver's af output stage. Tuned circuit L-C is peaked at the receiver's if to provide maximum rf input to the scope.

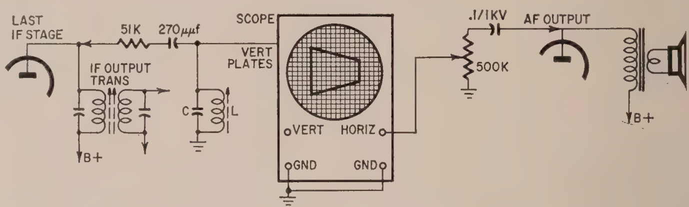


Fig. 7—Setup for producing trapezoidal modulation patterns at receiver.

Fig. 8 shows trapezoidal modulation patterns. Adjust the coupling to the if amplifier so an unmodulated carrier produces a vertical line somewhat less than half the screen diameter. If a direct connection to the if plate produces too much vertical sweep, make the connection to a gimmick around the plate lead. Adjust the potentiometer for satisfactory horizontal sweep. END

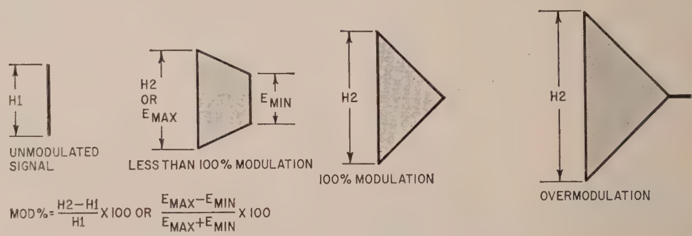


Fig. 8—Trapezoidal patterns representing different degrees of modulation.

SERVICE CLINIC

Conducted by
JACK DARR
SERVICE EDITOR

This column is for your service questions. We answer them free of charge and your name and address will be kept confidential if you wish. The main purpose is to help those working in electronics with their problems.

We've changed our target a little and are no longer restricted to TV. Radio, audio and industrial electronics problems are also grist for the mill. All letters get a prompt individual answer and the more interesting ones will be printed here. So if you have a service problem, send it here. We'll do our very best to help you solve it.

I've noticed a lot of cases lately where the trouble being described seems to center around defective electrolytic capacitors. So this might be a good time to work over a few characteristics of electrolytic capacitor troubles and give some cures for them.

There are two defects in electrolytics—shorts and opens. If you can't locate a shorted unit, we just won't bother with *you* any further. However, open electrolytics can cause some strange and wonderful symptoms!

In addition to the completely open unit, you'll find some that are only partly open—decreased capacitance or filtering efficiency. The power factor of an electrolytic determines its filtering efficiency. Actually, the power factor is just about proportional to the leakage through the capacitor, so we can use the leakage as a sort of guide to the condition of the capacitor. This leakage has the same effect as a resistor shunted across the capacitor. Of course, this fouls up the voltage ratios in all the voltage-divider circuits in many TV receivers and away we go.

The completely open capacitor we can locate by bridging or shunting (whichever term you prefer). The partly open, low-capacitance or high-power-factor electrolytic very often defies diagnosis by this method! So to be perfectly sure, open a suspected capacitor completely, then connect your substitute.

The scope is about the handiest tool to use for this kind of diagnosis. By connecting a low-capacitance probe across points in a circuit suspected of harboring undesired hash or feedback, we can locate it in a matter of minutes. Leaving the scope connected while a good capacitor is bridged across the suspected unit will almost always give us a pretty good idea of what's going on in the circuit. If you can't tell whether or not the hash seen is too high in amplitude, shunt the nearest capacitor and watch the scope. If the hash drops to a thin horizontal line, and at least some of your symptoms clear up at the same time, you're making progress.

For instance, if you have a shadowy hum-bar on the screen, one so faint that you really can't tell whether it's definitely there, check the ripple level at the output of the filter. It ought to be somewhere around 0.2 to 0.5 volt peak to peak (p-p); very little more. So if you find say, 5 or 6 volts p-p at the filter output, shunt the output filter capacitor and see what happens to the ripple. Also, go out along the circuit, say to the audio plate, video plate, CRT grid, and check for any trace of 60- or 120-cycle signal there. Watch these while shunting various capacitors. They'll tell you whether the electrolytics are ripe for replacement.

We left the worst until the last—the intermittent electrolytic. These do not seem to be as common as they once were—but like relatives, they pop up when you least expect them. I'd say that improvements in manufacturing have done more good than anything else in reducing this trouble.

All of us at one time or another have had the happy experience of an intermittent electrolytic closing up firmly after another unit was shunted across it and working perfectly for a long time. The only way to get a reliable check on such a condition is to sneak the replacement capacitor into the circuit. Several people make capacitor substitution boxes with built-in provisions for this. You can do the same thing by connecting a potentiometer, about 500,000 ohms, in series with the shunt capacitor. Connect this into the circuit, then reduce the resistance in the circuit until the new capacitor is directly across the suspected points. This, together with your scope will tell you what's going on.

There are quite a few rough checks that can be applied to localize possible trouble spots in this department. One of them is heat. Feel a suspected capacitor with your fingers. If it is unpleasantly warm, look out. This is assuming that the capacitor is not located near any source of heat, such as the 5U4, horizontal output tube, etc.

The heat here is caused by excessive leakage current *through* the capacitor, causing an internal temperature rise. This results in a fast boiling away of the electrolyte, and an open capacitor. Actually, a so-called dry electroyltic isn't any drier than a dry-cell flashlight battery. They're both damp. Without water in some form or other, both of these devices would fail. The major activity in both capacitor and battery is chemical, and water is a necessity.

A hot capacitor should be carefully checked for capacitance, leakage and power factor. If it shows bad, and it *is* located near a source of high heat, don't hesitate to relocate it — if there is any room on the chassis. The high ambient temperature has probably hastened the downfall of the original unit.

Color drift

In an Admiral, model C322C2 color TV, the screen has a decided magenta tint when it first comes on. After about 2 minutes, it makes a pretty good black-and-white picture. If I set the green screen and grid controls with the set cold, the picture is OK, but it gets greenish after it is thoroughly warmed up.—R. P., Clio, S. C.

From the symptoms, there is only one thing wrong with it. When cold, you don't have enough green—in the monochrome raster, that is. Obviously, something is reducing the amplitude of the green gun's output. After warmup, the green gun comes up to normal.

I'd say that this was a defective

(*Continued on page* 64)

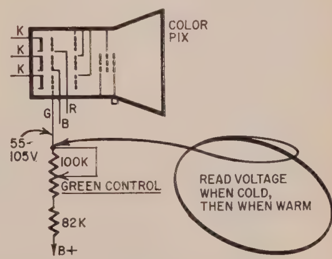


Fig. 1—Check grid and cathode voltages on the color crt to find out which one is causing the color temperature drift.

(*Continued from page* 61)

resistor. Also, it is somewhere in the green grid or screen circuit: (Fig. 1). Hook a dc vtvm to the green cathode or grid, preferably the grid, and turn the set on. This voltage ought to read between 55 and 105, depending on the position of your controls—brightness, contrast, etc. Leave all controls alone and see what happens as the set warms up. If the green grid voltage drifts quite a bit, the trouble is bound to be in one of the resistors in the supply circuits. If the green stays the same, check the other grids. Since this set, like many others, does not amplify the green directly, but makes it out of the blue and red, matrixing it between the R — Y and B — Y amplifiers, there is a possibility that one of the other two is slightly slow heating. Measure all of the grid and cathode voltages on the CRT and check out the circuit which shows the drift.

Sweep-alignment query

There is something I'd like to know about sweep alignment. Some manufacturers recommend connecting the sweep generator to the antenna. After all, it's the combined tuner–if response that determines picture quality, isn't it?

The normal effect of the fine tuning control is to move the video and sound markers along the curve. This is also what we are trying to do when we align a set, isn't it? So, the question is, where should we set the fine tuning before starting the overall response curve check?—G. B., Hoisington, Kan.

Let's go back a little and straighten something out before answering this fully. The results you get when making sweep-alignment adjustments depend on your concept of their purpose. So, let us take a look at that first.

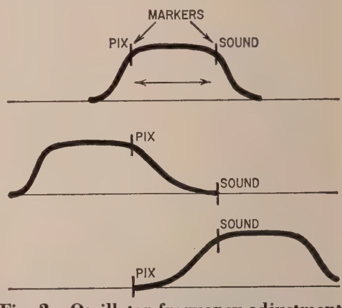


Fig. 2—Oscillator frequency adjustment moves the curve from side to side. The markers stand still.

If we display a sweep response curve of a TV set on a scope, we put marker frequencies on it to be able to identify certain particular frequencies. These markers are always fixed. If we change the oscillator frequency of the TV set, we'll move the curve from side to side, but the markers will stay right where they are (Fig. 2). We can do the same thing by tuning the sweep generator, of course. However, after we get a curve on the scope, we can move

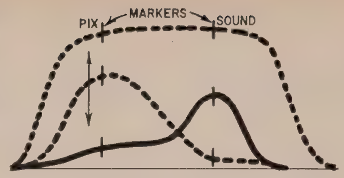


Fig. 3—Alignment adjustment moves the markers up or down. The curve stands still, although its shape changes.

the markers, but only up or down. We do this by tuning the if, tuner, etc., which alters the amplitude response of the circuits at certain frequencies Fig. 3). So always remember this principle. **Oscillator or sweep-generator adjustments move the *curve* from side to side. Tuning or alignment adjustments move the *markers* (or, to be precise, the portion of the curve where the markers are seen!) up or down, never sidewise!**

Finally, to answer your question, your fine-tuning adjustment should be set in the center of its range and left alone during the whole alignment process. Final adjustment of the tuner oscillator slugs, etc. should be made on a TV station signal for best picture and sound. If the fine tuning is centered, the user has the maximum range of adjustment after you finish.

Vertical bars

I am servicing an Emerson 120245D which has alternating light and dark bars running from top to bottom of the screen. These seem to overlap the picture and are not changed by the contrast control. They are about 2 inches wide with normal picture brightness between. All voltages check out, and nothing shows up on a scope. Edges of the raster are straight.—B. H., East Moline, Ill.

I gather from your description that the bars are about equally spaced all the way across the screen. If they were heavier at left, fading out toward the right, this would be plain old yoke ringing. However, I believe this is something else. I have encountered this trouble before, although not in the same make set, and it is quite rare.

Check the balun coil between the antenna and the tuner. A certain combination of broken wires on the coils will cause a weird sort of unbalance here, and the antenna lead will pick up the 70-kc harmonic radiation from the flyback–yoke system. This causes the alternating bars across the raster. A break in one of the conductors of the lead-in, near the set, will do the same thing.

One other thing might be of some assistance, if the balun is OK. Shield the yoke leads by wrapping them with aluminum foil. Ground the foil by wrapping a bare wire spirally around the cable, fastening it to the yoke bracket at one end and the chassis at the other. Don't let it get too close to the yoke terminals, or you might get flashover.

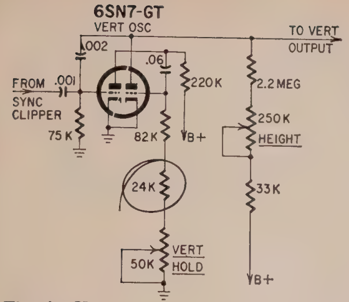


Fig. 4—Vertical oscillator circuit of G-E 810. Juggle circled resistor to stop picture rolling.

Be sure that the high-voltage shield (the doghouse) is in place and well fastened.

Vertical roll

I'm working on a G-E 810. The complaint is a vertical rolling, but I've checked all voltages and resistances, and they seem to be within the tolerance. I've changed the tubes, with no results.—F. A., Los Angeles, Calif.

This type of vertical oscillator is very common in all kinds of TV sets (Fig. 4). First check or replace all capacitors that show even the slightest sign of dc leakage. Even a very small dc leak will make this oscillator circuit hard to hold.

Next check the resistance values, especially plate load and grid resistors. In this particular chassis, if everything else checks out, juggle the value of the 24,000-ohm resistor in the grid circuit of the second triode section till you get the picture to stop with the hold control somewhere near the center of its range. You might even replace the hold control with a slightly larger unit.

New CRT

What changes would be necessary in a G-E 21T25 so that a 21ZP4B could replace a 21ARP4?—R. E. H., Fitchburg, Mass.

You can use the 21ZP4B as a replacement for the 21ARP4 by simply providing some means for focusing the tube. The 'ZP4 tubes are magnetic-focus types, so you have to add an EIA No. 109 focus coil (or its PM equivalent).

I have a better suggestion: a type 21JP4 is an exact replacement for the 21ARP4. However, a 21XP4 or 21YP4 would be less expensive for replacement purposes; both of these are electrostatically focussed tubes. Run a wire from pin 6 of the tube base to some point in the circuit; use whatever dc voltage gives the best focus (anywhere from +250 volts to ground).

White streaking

The set in question is a General Electric M4 chassis. After it is on for 5 minutes or so, small white "pellets" streak across the screen. In a short while the interference resolves itself into a jagged white bar about 1 inch in width. It looks like Barkhausen or spook interference, with one difference, it flits back and forth across the face of the screen. With no picture content the bar disappears. Could it be a parasitic oscillation in the horizontal system? I can get no help on this from anyone.—W E. G., Bronx, N. Y.

This interference is undoubtedly related to the horizontal system and is getting into the video as you say, with a blank raster, the phenomenon disappears. You'll find the same thing in some sets with black dots and streaks instead of white. It depends on the polarity of the signal which is being picked up and at what point in the circuit the pickup takes place.

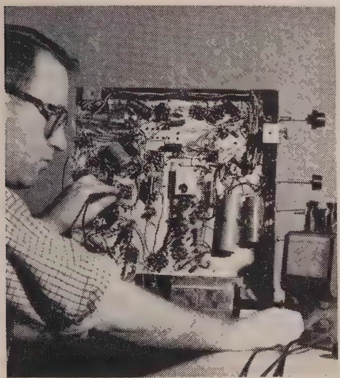
This is usually due to parasitics in the the horizontal sweep circuits. These can be eliminated by inserting small (47-ohm) resistors in series with the output tube plate and screen leads, or by using small well-insulated rf chokes (such as the type used in some TV set heater circuits).

It can also be due to radiation from the sweep circuits getting into the antenna lead to the tuner. Dress this lead as far away from the horizontal system as possible and secure all shielding (the doghouse, etc.). Now and then a set comes in without the doghouse; some careless technician has left it off completely! In a case like this, replace it, either by getting a duplicate or making one out of copper screening. END

HOME STUDY COURSES *in*

Electronic Fundamentals • TV Servicing Color TV • Electronics for Automation • Transistors

Voluntary Tuition Plan. The important thing to remember about RCA Institutes Training is the convenient, *no-obligation payment plan.* This plan affords you the most economical possible method of home study training because you pay for each study group only when you order it. If you interrupt your course *at any time, for any reason,* you owe nothing more. You *never* have to pay for the whole course if you don't complete it. No other obligations. No monthly installment payments!



RCA Instruction is Personal. With RCA Home Study training you set *your own pace* in keeping with *your own ability,* finances, and time. The Institutes allows you ample time to complete the course. Your lesson assignments are individually graded by technically trained personnel, and helpful comments are added where required. You get theory, experiment, and service practice beginning with the very first lesson. All lessons are profusely illustrated. You get *a complete training package* throughout the entire course.

You Get Prime Quality Equipment. All kits furnished with the course are complete in every respect, and the equipment is top grade. You keep all the equipment furnished to you for actual use on the job . . . *and you never have to take apart one piece to build another!*

★ ★ ★

RESIDENT SCHOOLS *in*

Los Angeles and New York City train you for any field of Electronics you may choose!

No Previous Technical Training Required For Admission. RCA Institutes Resident Schools in Los Angeles and New York City offer training that will prepare you to work in rewarding positions on research and production projects in fields such as automation, communications, technical writing, television, computers, and other industrial and advanced electronics applications. Even if you did not complete high school, RCA will prepare you for such training with courses specially designed to provide the basic math and physics required for a career in electronics.

Free Placement Service. RCA Institutes graduates are now employed in important jobs at military installations such as Cape Canaveral, with important companies such as IBM, Bell Telephone Labs, General Electric, RCA, and in radio and TV stations all over the country. Many other graduates have opened their own businesses. A recent New York Resident School class had 92.06% of the graduates who used the Free Placement Service accepted by important electronics companies... *and had their jobs waiting for them on the day they graduated!*

Coeducational Day and Evening Courses. Day and Evening Courses are available at Resident Schools in New York City and Los Angeles. You can prepare for your career in electronics while continuing your normal full-time or part-time employment. Regular classes start four times each year.

SEND POSTCARD FOR FREE ILLUSTRATED BOOK TODAY! SPECIFY HOME STUDY OR RESIDENT SCHOOL

RCA INSTITUTES, INC. A SERVICE OF RADIO CORPORATION OF AMERICA, 350 W. 4th St., New York 14, N. Y., 610 S. Main St., Los Angeles 14, Calif.

RCA® The Most Trusted Name in Electronics

FM tuner problem

By **HERMAN BURSTEIN**

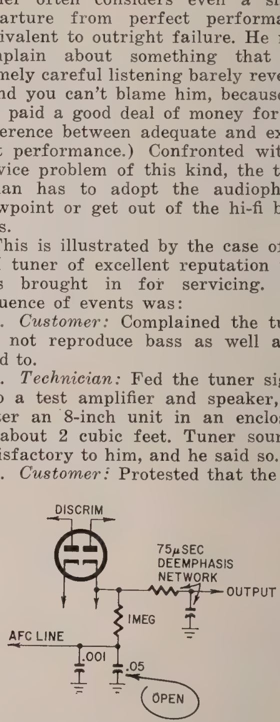
SOME of the toughest service problems involve electronic units that are just a bit out of kilter rather than completely out of commission. One is particularly likely to run into this kind of situation with hi-fi components. The owner often considers even a slight departure from perfect performance equivalent to outright failure. He may complain about something that extremely careful listening barely reveals. (And you can't blame him, because he has paid a good deal of money for the difference between adequate and excellent performance.) Confronted with a service problem of this kind, the technician has to adopt the audiophile's viewpoint or get out of the hi-fi business.

This is illustrated by the case of an FM tuner of excellent reputation that was brought in for servicing. The sequence of events was:

1. *Customer:* Complained the tuner did not reproduce bass as well as it used to.

2. *Technician:* Fed the tuner signal into a test amplifier and speaker, the latter an 8-inch unit in an enclosure of about 2 cubic feet. Tuner sounded satisfactory to him, and he said so.

3. *Customer:* Protested that the test



speaker was inadequate for low frequencies, compared with the speaker system in his home.

4. *Technician:* Went to special effort of feeding the tuner signal to a large speaker system with bass response beyond dispute. Tuner again sounded all right to him, and he said so.

5. *Customer:* Still insisted that the bass was not what it used to be.

6. *Technician:* Hooked up a test FM tuner of very good make to the amplifier and switched alternately between the test tuner and the customer's tuner

on the same stations. There was no apparent difference on the first couple of stations. Then he tuned in a symphonic recording containing passages with full bass. Now there was a definite difference. The test tuner had solid bass with considerable impact. The customer's tuner sounded wan at the very low end. The technician accepted the tuner for servicing.

7. *Technician:* First thought that the tuner's output coupling capacitor had dropped appreciably in value, reducing bass output. But a check of the .05-μf output capacitor proved it was perfectly all right. With the usual input resistance of about 500,000 ohms presented by most preamplifiers, this would insure bass response flat within 1 db down to about 13 cycles.

8. *Technician:* Cogitated for a while. Referred to schematic. Cogitated some more. While listening to a program with appreciable bass content, he flicked the afc switch to the off position. Immediately the bass improved. He checked the parallel .05- and .001-μf filter capacitors in the afc line, shown in the diagram. (The .001-μf capacitor, ceramic, insures filtering of the high frequencies, which may be inadequately shunted to ground by the larger capacitor owing to its inductance.) The .05 capacitor proved open.

For proper afc action, the signal reaching the reactance tube must be dc—either negative or positive, depending on whether the tuner is set above or below the FM station's center frequency. If an ac (audio) frequency reaches the reactance tube, it causes the oscillator frequency to swing in step with the frequency deviations of the incoming FM signal. Therefore frequency deviations are reduced, causing lower audio output, which varies in magnitude with the amount of frequency deviation.

In the case illustrated, where the .05-μf capacitor was open, the time constant of the .001-μf capacitor and the 1-megohm resistor in the afc line was too small to shunt the low audio frequencies to ground. Therefore these low frequencies were reaching the reactance tube, causing loss of bass for the reason explained.

9. *Technician:* Put in a new .05-μf capacitor. Now bass was as good with afc on as off.

10. *Customer:* Listened to the repaired tuner. Nodded happily, cheerfully paid his bill, and walked out satisfied he had found the right man for servicing the hi-fi systems owned by him and his friends. END

Canada Approves Stereo

The Board of Broadcasters of the Canadian Board of Transport has approved standards for FM stereo identical to those adopted in the United States. Up to the time of writing, no information on the number of stations expected to broadcast stereo in Canada was available. Some Canadian manufacturers are already making multiplex adapters and receivers.

MAKE A 5-μa Relay

Take a power transistor, convert it to a phototransistor and add one microammeter to get an ultrasensitive relay

By MARTIN H. PATRICK

A SINGLE transistor acting as a photocell can be used to convert a microammeter into a supersensitive relay which operates at the unusually low current of 5 μa. It takes a little work, but the results are worth the trouble.

If you have a meter that has been abused by too much pegging or if you feel you would like to tamper with that old one that has seen better days, give this stunt a try. Drill a 5/64-inch hole through the face of the meter at a point where the needle movement will produce the greatest amount of light shading (Fig. 1-a). The hole must extend through the back of the meter where a pilot light is set up to provide the necessary illumination (Fig. 1-b). To do this, you will have to remove the meter from its case. Careful planning and handling will get the hole in the right spot.

A power transistor such as Lafayette's SP-147 (77¢) makes an effective photocell for this application. Carefully remove the top of the transistor's case by drilling a ⅛-inch hole close to the outer edge, away from where the germanium wafer is. Look for an indentation under the mounting base. The wafer is right above it. Then, with sharp wire-cutting pliers cut away the top, being careful not to damage the wafer. It's a good idea to anchor the transistor rigidly by its edge in a vise. [A cadmium sulphide or other commercial photocell might also work.—*Editor*] A good photosensitive transistor develops about 0.5 ma when connected as shown in Fig. 2 and exposed to a 100-watt lamp.

Some power transistors have more leakage than others. Therefore, it may be necessary to compensate for this by shunting the transistor's emitter and collector with a suitable value resistor. To determine what value to use, try a few resistors and select the one that lets the relay open when the light beam

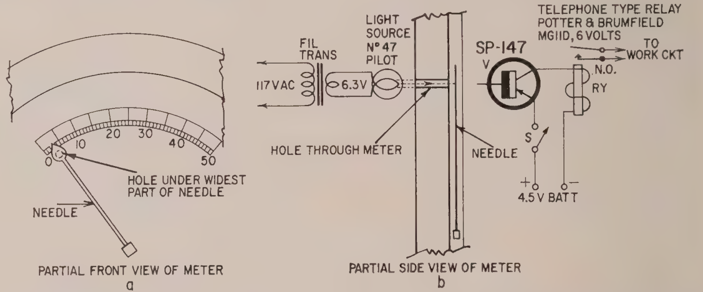


Fig. 1-a—Drill a hole through the face of the meter so that the meter needle will cover it as it moves up scale. b—Circuit of the ultrasensitive relay.

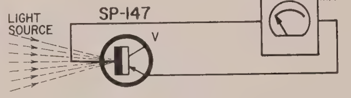


Fig. 2—Simple setup for testing transistor photosensitivity.

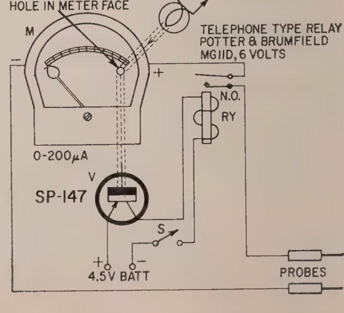


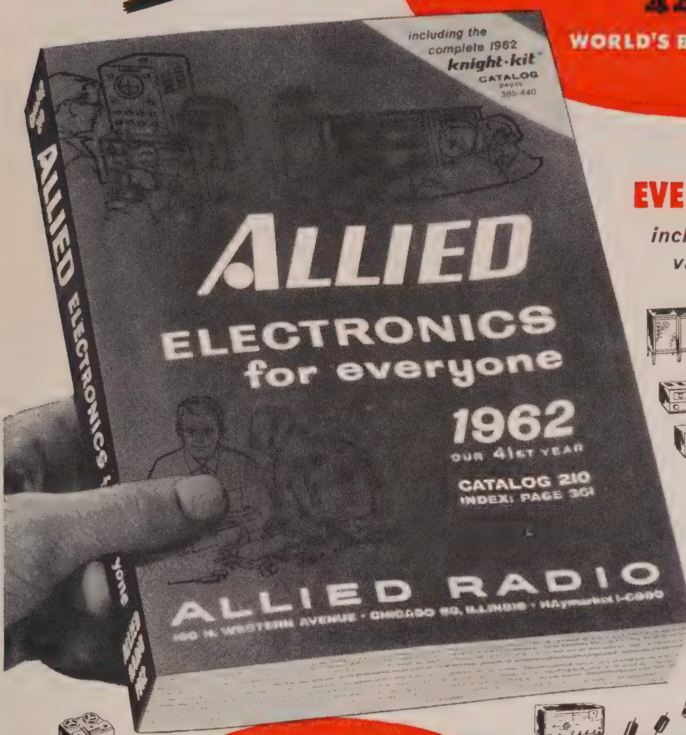
Fig. 3—Meter protection circuit. Full-scale movement of needle breaks light beam, triggering relay that opens the meter circuit.

Free

ALLIED 1962 ELECTRONICS CATALOG

444 PAGES!

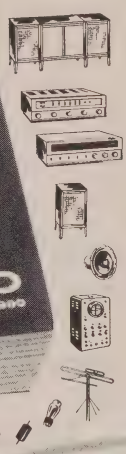
WORLD'S BIGGEST—MOST COMPLETE



SAVE MOST ON

EVERYTHING IN ELECTRONICS

including exclusive products & special values available only from ALLIED



- New Multiplex Stereo FM—All-Transistor Stereo Hi-Fi
- New Stereo Hi-Fi Systems—Everything in Hi-Fi Components
- Money-Saving Build-Your-Own KNIGHT-KITS® for Every Need
- Best Buys in Tape Recorders, Tape and Recording Supplies
- Citizens Band 2-Way Radios
- Amateur Receivers, Transmitters, and Station Gear
- Public Address Systems, Paging and Intercom Equipment
- Test and Laboratory Instruments
- TV Tubes, Antennas, Accessories
- Batteries, Wire, Tools, Hardware
- Huge Listings of Parts, Tubes, Transistors, Technical Books

NEW Multiplex Stereo FM
All-Transistor Stereo Hi-Fi

NO MONEY DOWN
on Allied's new Credit Fund Plan

Now—enjoy 50% more buying power—up to 24 months to pay—see our 1962 Catalog for simple details.

ALLIED exclusives:

MONEY-SAVING KNIGHT-KITS®. Enjoy the most satisfying do-it-yourself experience in the world! Build KNIGHT-KITS—lowest in cost, easiest to assemble, best for performance. Select from over 90 exciting KNIGHT-KITS—Stereo, Hi-Fi, Hobbyist, Amateur and Test Instruments. An exclusive ALLIED product.

BEST-BUY KNIGHT® PRODUCTS. Save most on famous KNIGHT Stereo Hi-Fi—comparable to the best in quality, styling, performance—yet priced far lower. Select super-value KNIGHT components or complete systems (including latest Multiplex Stereo and All-Transistor Hi-Fi). KNIGHT products are acclaimed by all who recognize integrity in design and manufacture and who appreciate value.

- World's Largest Stocks • Lowest Money-Saving Prices
- Fastest Shipment • Expert Personal Service

send today for the world's biggest electronics catalog!

Free

ALLIED RADIO, Dept. 227-M1
100 N. Western Ave., Chicago 80, Ill.

☐ Send FREE 1962 ALLIED 444-page Catalog

*Name*____________________
PLEASE PRINT

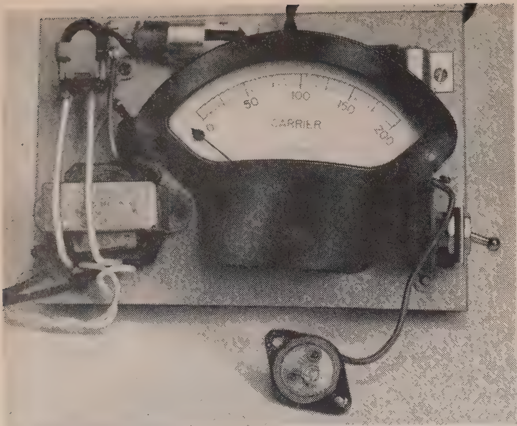
*Address*____________________

*City*__________ *Zone*____ *State*______

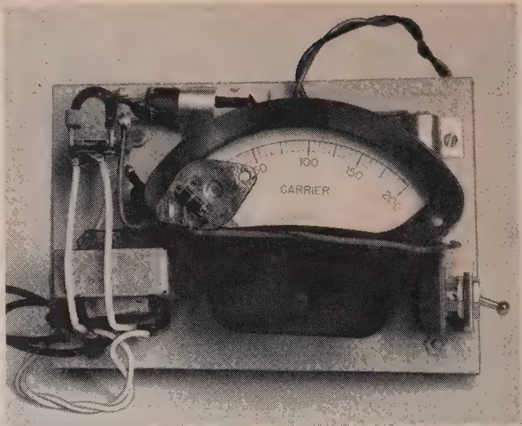
ALLIED RADIO

World's Largest Electronic Supply House

Satisfaction Guaranteed or Your Money Back



Relay is in closed wood box so line-cord connections to filament transformer are not exposed. Note power transistor with top off.



The 5-μa relay with the transistor placed so the light coming through the meter face strikes the germanium wafer.

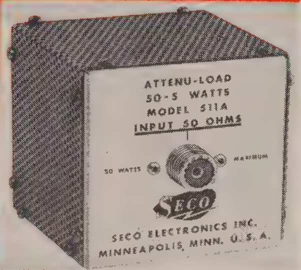
is interrupted by the meter needle.

Mount the transistor on the front of the meter in line with the hole. The meter needle should interrupt the light beam shining through the hole. By adjusting the meter movement, you may be able to actuate the relay at perhaps an even smaller current. If you intend to use the relay as a permanent setup, insert a very fine wire in the light hole to act as a stop for the meter pointer. This will insure actuating the relay at higher currents that would normally move the pointer past the hole.

The same arrangement can be used to protect a sensitive microammeter against pegging—the result of unexpected overloads or accidental shorts. Simply drill a small hole at or near the full-scale reading and use the same circuit arrangement as for the sensitive relay. Relay contacts are used as part of the microammeter circuit, in series with work under test (Fig. 3). As soon as needle movement caused by an overload breaks the light beam, the relay contacts open, thus opening the meter circuit and preventing the needle from banging full scale. The relay will have to be a latching type.

The uses for this type of supersensitive relay are numerous. For example, a powerful local station that will produce about 5 μa (rectified) in a resonant circuit can actuate the relay. It is especially useful with thermal electricity. Almost any two dissimilar metals twisted together and heated will produce 5 μa or more. Or you can use a PM speaker with one stage of audio amplification to make a sound-actuated relay. END

NEW CB XMITTER TESTERS



By WAYNE LEMONS

An rf and modulation tester for high- and low-power rigs, plus an antenna checker and standing-wave meter speed analysis and servicing.

Just how efficient is your Citizens-band rig or amateur transmitter? How efficient is your antenna as a radiator? Or what's your percentage of modulation — talk power? Without some sort of test equipment it is a virtual certainty that you have no idea. Some new equipment designed to answer these questions has just been introduced.

These new instruments cover 3 to 180 mc, so they can be used to test the bulk of AM transmitters in use today.

The model 510 transmitter tester measures power output up to 5 watts and, with the model 511A Attenu-Load as an accessory, up to 50 watts, it measures modulation percentage of both positive and negative peaks. It can also act as a dummy load.

The 520 antenna tester is a standing-wave-ratio indicator that determines antenna efficiency. All three are made by Seco Electronics.

How they work

The model 510 transmitter tester is an absorption type wattmeter (Fig. 1). Transmitter power is dissipated in a 51-ohm resistive load. Diode D1 rectifies an rf sample and the resulting dc goes through an rf filter and calibration control to a meter calibrated in watts.

With the selector switch in position 1 or 2, for checking modulation percentage on negative or positive peaks, the rf is fed through D4 in series with an RF LEVEL control (Fig. 2). With the pushbutton depressed, the rectified dc goes through an rf filter to the meter. The RF LEVEL control is adjusted until the meter reads at the RF SET position. When the pushbutton is released, a 5-μf capacitor is inserted in series with

(*Continued on page* 80)

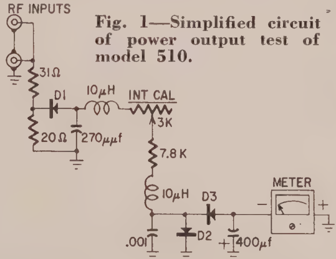


Fig. 1—Simplified circuit of power output test of model 510.

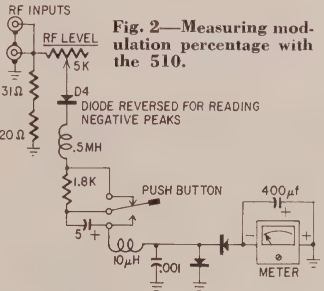


Fig. 2—Measuring modulation percentage with the 510.

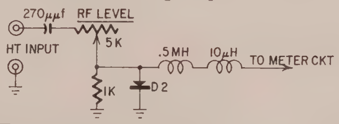
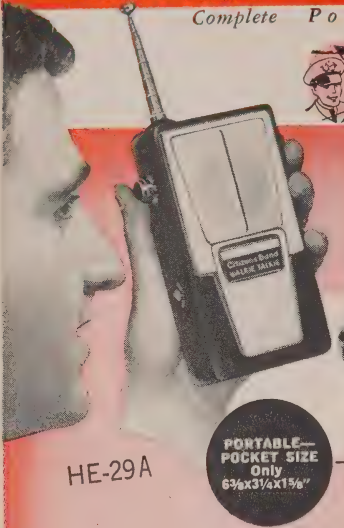


Fig. 3—The 510 uses this relative power circuit for checking output of low-power units.

LAFAYETTE is America's Citizens Band Headquarters

Complete Portable Communications for Everyone

NO LICENSES, TESTS OR AGE LIMITS



PORTABLE—POCKET SIZE Only 6⅜x3¼x1⅝"

HE-29A

LAFAYETTE 9 TRANSISTOR *CITIZENS BAND* "WALKIE TALKIE"

39.95
2 for 78.88
NO MONEY DOWN

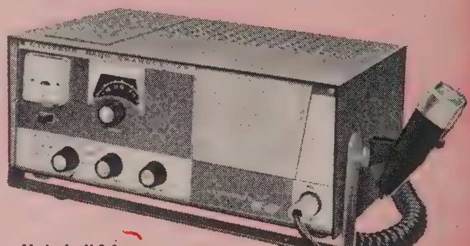
Complete with Leather Carrying Case, Earphone, Antenna, Batteries, and Crystal

- Completely Wired—Ready to Operate • Fully Transistorized—9 Transistors plus 1 Diode • Uses Inexpensive Penlight Batteries • No License, Tests or Age Limits • Comes with Leather Carrying Case, Earphone, Antenna, Batteries and Crystals

As simple and easy to use as the telephone—and twice as handy. Receives and transmits up to 1.5 miles under average conditions. Weighs only 18-oz. and slips into your pocket. Push-to-talk button operates built-in speaker as sensitive microphone.

LAFAYETTE HE-20A *Deluxe* CITIZENS BAND TRANSCEIVER

ONLY **109.50**
NO MONEY DOWN



Made in U.S.A.

Now With Added Deluxe Features—

- Pi-Network for Greater Power Output • Calibrated "S" Meter • 14 Tube Performance, 3 Diodes • Built-in 12 Volt Power Supply for Mobile Use • Complete with Matched Crystals for Channel 9

A highly efficient 2-way communications system operating over a distance of up to 20 miles or more depending on terrain. Features 4 crystal-controlled transmit positions and 4 crystal-controlled receive positions. Tuneable superhet receiver covers all 23 assigned channels. Other highlights include dependable push-to-talk ceramic mike & relay, adjustable squelch control, automatic series gate noise limiter and illuminated dial.

NEW! LAFAYETTE TE-20 RF SIGNAL GENERATOR

ONLY **27.95**
NO MONEY DOWN

- Factory Calibrated and Tested. Six Bands: 120 KC-260 MC. Dual output RF Terminals
- Separate Variable Audio Output. Dial Calibration ± 2%. Etched Circular Dial — (Vernier Tuned)

A stable, wide-range signal generator engineered to fill the need for an accurate, low cost service instrument. Completely wired and ready to operate, the TE-20 features a large 4¼" etched circular dial calibrated to ± 2% with a frequency output of from 120 KC to 260MC in 6 bands. Built-in audio oscillator, adjustable output to 8 volts, variable RF antenuator and a host of other features. Steel case with leather carrying handle.

EXCITING "EXPLOR-AIR" 4-BAND RECEIVER KIT

Complete Shortwave and Standard Broadcast Reception

- 4 Bands For Total Coverage
- Complete Bandswitching From Front Panel
- Built-in 4" PM Loudspeaker
- 550 KC — 30 MC

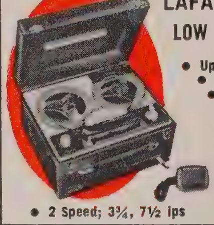
21.95 NO MONEY DOWN

Made in U.S.A.

Precision compact radio kit with everything you need for unexcelled reception. Size: 10x7x5"

KT-135 (less cabinet) 21.95
ML-150 Leatherette covered wood cabinet 2.75

LAFAYETTE RK-400WX SENSATIONALLY LOW PRICED AT 49.50 NO MONEY DOWN



- Up to 2-hours at 3¾ ips on LP Tape
- Provision For External Speakers
- Permits Direct Recording From Radio or Phono
- 2 Speed; 3¾, 7½ ips

The perfect recorder for home, school or office. Complete recording facilities with built-in amplifier. 5" PM Speaker and sensitive crystal microphone. Foolproof operation with facilities for direct recording from your radios or phonograph without accompanying noise or distortion. Finished in attractive scuff resistant pyroxylin material. Size: 11¾x9⅞x7½".

LAFAYETTE RADIO

SEND MAIL ORDER TO LAFAYETTE RADIO
111 JERICHO TURNPIKE
SYOSSET, LONG ISLAND, NEW YORK

PLEASE INCLUDE SHIPPING CHARGES WITH ORDER.

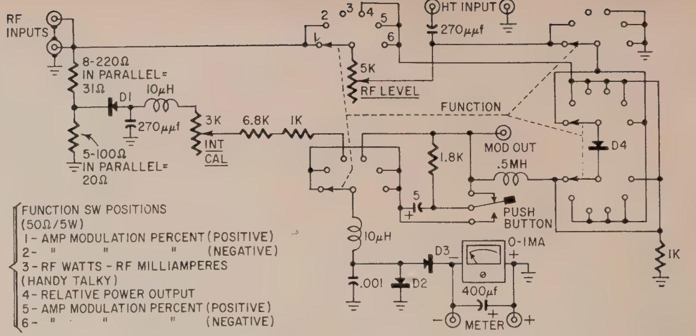
OTHER LOCATIONS	NEW YORK, N.Y. 100 6th Avenue	NEWARK, N.J. 24 Central Avenue	PARAMUS, N.J. 182 Route 17
JAMAICA, N.Y. 165-08 Liberty Avenue	BRONX, N.Y. 542 E. Fordham Rd.	BOSTON, MASS. 110 Federal Street	PLAINFIELD, N.J. 139 W. 2nd Street

(*Continued from page 77*)

the rectified dc. Now there is no meter reading from a steady carrier but, when the carrier is modulated, the audio component deflects the meter. This is the modulation test. By reversing diode D4, both positive and negative peaks can be read.

On low-power rigs that do not have 50-ohm outputs, the rf is coupled in as shown in Fig. 3. Only relative power measurements can be made here. Coupling to these must be kept low (small meter readings) so they are not loaded too heavily. Modulation is read as a percentage of this low reference level (Fig. 4).

For higher-power transmitters, the model 511A Attenu-Load must be placed in the feed line between the transmitter and the 510. This enables the two instruments to measure rf output up to 50 watts, as well as modulation percentages. Fig. 5 shows the Attenu-Load circuit.



Complete circuit of the model 510 CB transmitter tester.

Antenna tester

The model 520 antenna tester is a directional rf indicating device. Its basic circuit is shown in Fig. 6. A directional coupler which is a short section of air-dielectric transmission line is inserted in series with the feed line to the antenna. Two back-to-back indicating circuits are coupled inductively and capacitively to the short section of transmission line in the 520. They are arranged so that one indicates the power going to the antenna while the other indicates the power reflected from it. If the outgoing (forward) power is high as compared with the returning (reflected) power, the efficiency of the radiator (antenna) is good. This is a low standing-wave ratio (SWR). (Standing waves are those that are reflected down the feed line.) SWR is calculated by the formula $\frac{v_f + v_r}{v_f - v_r}$ where: v_f = forward voltage and v_r = reflected voltage.

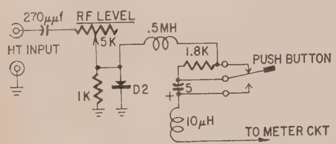


Fig. 4—Low-power modulation-indicator circuit.

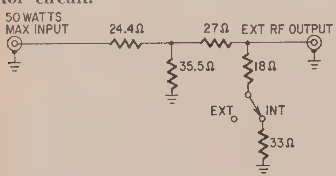


Fig. 5—The 511A Attenu-Load uses this circuit arrangement.

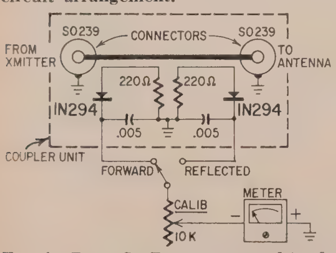


Fig. 6—Basic SWR setup as used in the 520 antenna tester.

If there is no reflected voltage, the ratio is low—1 to 1. The larger number is usually read first. Thus, if the SWR is high, it would be read 5 to 1, 6 to 1, etc. On the 520, a GOOD–POOR scale is included for the nontechnical observer.

The 520 can be used with transmitters with up to 1,000 watts maximum output and may be left in the line as an output indicator. You can read the actual output of all transmitters from 0.5 to 1,000 watts in the frequency range of 3.5 to 180 mc.

Using the instruments

Let's say the complaint is that a CB or other station can't be heard or is weak. Connect the 510 transmitter tester to the antenna connector of the transmitter. (A special adapter cable and two parallel inputs permit connection to just about any transmitter regardless of the type of coax connector used.) Turn on the transmitter. If the CB transmitter develops 1.5 to 2.5 watts, it has ample rf output. [Remember this is the actual rf output into a 50-ohm load and should not be confused with the 5 watts input (output plate voltage times current, designated by the FCC as maximum). Few transmitters have greater than 50% efficiency.]

If the rf output is low, you probably have a weak transmitting tube, defective crystal or component. Or perhaps the transmitter is improperly tuned or the input voltage is low.

If the rf is normal, you are ready to make a modulation check. Switch to the proper position and calibrate the 510. Talk directly and distinctly into the mike at a distance of 1 to 2 inches, but do not shout. The meter should deflect upward to near 100%. (Some transmitter designs restrict modulation to around 75%.) If modulation is low, it should be corrected. A lack of "talk power" restricts the range as surely as low rf carrier power. Check for weak tubes, low voltages, defective mike, etc.

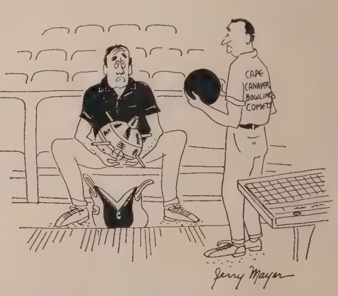
Whatever the trouble, you now know in what transmitter section to look.

The antenna tester will often spot antenna faults that cannot be detected any other way. On new installations always check and record the SWR. This not only spots possible antenna or lead-line defects in the installation, but is invaluable as a guide for antenna performance in subsequent service. Most commercial antennas have low SWR. So if a SWR is high, check for improper feed-line impedance, poor connections, etc. Corroded or loose connections that may not show up on an ohmmeter—even if it were possible to make the test—are immediately detected by the 520.

If you build your own antenna, you must know its efficiency—you may be losing half or more of your power in standing-wave reflections. Remember, adjustments at the transmitter end have no effect on SWR. Only a properly matched feed line and antenna can eliminate radiation losses from standing waves.

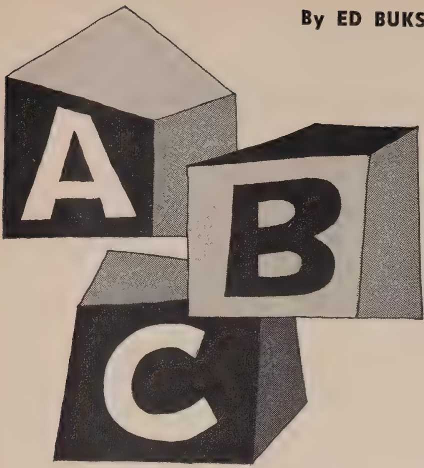
You can read the actual watts going into the feed line and antenna with the 520. The scale is calibrated 0–10. If you don't push any buttons, the scale must be multiplied by 100. In other words, you can read up to 1,000 watts forward power. Depressing the ×10 or ×1 buttons reduces the scale accordingly. Where SWR is high, you must subtract the reflected power from the forward power to arrive at the actual power going into the antenna.

The 520 may also be used on 72- to 75-ohm lines by simply subtracting 0.4 from the SWR scale. END



"Good grief! No wonder we didn't get a signal from that satellite we sent up today!"

By ED BUKSTEIN



INDUSTRIAL ELECTRONIC DICTIONARY

From one-shot multivibrator to photoelectric cutoff control

One-shot multivibrator: A type of multivibrator having only one stable state. The circuit is designed so that one side (tube or transistor) conducts and the other side is cut off. The circuit is not free-running and remains in this condition until triggered by an input pulse. Each input reverses the condition of the circuit, and the circuit returns to its initial condition after a length of time determined by component values, producing a "standardized" output pulse independent of the size and shape of the input trigger pulse. This makes the circuit useful in pulse-shaping applications. The one-shot multivibrator is also known as a *monostable multivibrator, delay multivibrator, univibrator* or *pulse equalizer*.

Open loop: A control system that does not use feedback for self-correction. The volume control of a radio receiver is part of an open-loop control system. This control can be used to adjust the volume level but does not provide any corrective action to maintain a constant volume level. The avc system, however, is part of a closed-loop system since it provides a corrective action (bias) to maintain a constant volume level.

Oscillograph recorder: Mechanical oscillograph in which a pen traces the waveform on a moving strip of paper. The pen is mechanically linked to a D'Arsonval movement so that changes of current flow cause the pen to deflect across the paper chart. A modification of this pen-and-ink type of recorder employs a heated stylus to write on a chemically treated paper that becomes discolored where it contacts the heated stylus.

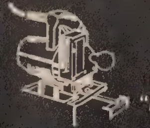
Although its frequency response is severely limited by the inertia of the mechanical components, the oscillograph recorder has the advantage (over conventional oscilloscopes) of producing a permanent record. Frequency response can be improved by using a beam of light as the writing element. The beam, reflected from a mirror galvanometer, writes on a strip of photographic film or paper. The chart is chemically developed to make the trace visible. The oscillograph recorder is also known as a strip-chart recorder.

Overshoot: The tendency of an automatic control system to overcorrect, causing the controlled quantity to pass through the desired value and to initiate an opposite correction (see Hunting).

Peaking transformer: Transformer designed to saturate at relatively low values of primary current. As shown in Fig. 18, changes of primary current produce changes of magnetic flux only for small values of current flow, and the core is saturated during most of the input cycle. Since voltage is induced in the secondary only when the magnetic flux is changing, secondary voltage is zero during most of the input cycle. The peaking transformer is useful as a waveshaping device, changing a sine

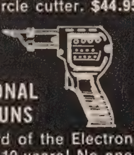
STOP AND SHOP

Look for this convenient display at your Electronic Parts Distributor (listed in the column at right). A full assortment of famous Wen power tools awaits your inspection. Step up to Wen quality—factory guaranteed to perform to professional standards.



FAMOUS "ALL SAW"

Best selling power saw in the business! A souped-up UL "Industrially Rated" ½ HP saw—equally great for 6" logs and delicate pattern work. Cuts virtually any material quickly, cleanly. Complete with 7 blades, rip guide, circle cutter. **$44.95.**

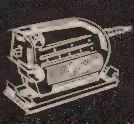


PROFESSIONAL SOLDER GUNS

The standard of the Electronic Industry for 10 years! No one—not even Wen—has been able to improve the Wen design. Quick heat, slim sturdy plastic housings. From feather-light 100 watts to 250 watt heavy duty. Guns and kits **$5.95 to $15.95.**

UNIVERSAL SABRE SAW

Lightweight and extremely versatile! Easily cuts 2 x 4's and fine scrollwork . . . any shape. Cuts wood, steel, wallboard, plastic, leather—anything normally cut with any saw. Powerful UL Approved motor. **$26.95.**



WORLD'S FINEST SANDERS

Choose from 3 models—all straight-line fine-finish types . . . all with plenty of power. Perfect for re-finishing and new wood work. Never a scratch to mar a good surface. 14,400 strokes per minute by sanding surfaces up to 20 sq. in. **$13.95 to $19.95.**

2-SPEED DOUBLE-DUTY DRILL

No other drill like it! Big ⅜" geared chuck—2 speeds. Change from 1000 RPM (heavy duty) to 3000 RPM (delicate work) in seconds. 2 ball thrust bearings . . . oversize oilite bearings. Drill, polish, sand, grind, wire brush, mix paint—you name it. Most versatile tool in your workshop. **$29.95.**

WEN PRODUCTS, INC.

5810 Northwest Highway, Chicago 31, Ill.

ALA., Opelika, Southern Electronics Corp.
CALIF., Buena Park, Ford Electronics
Burbank, Electronic City, Inc.
Downey, Master Electronic Supply, Inc.
Hollywood, Hollywood Radio & Electronics, Inc.
Yale Radio Electric Co.
Inglewood, Acorn Radio & Electronics
Long Beach, Larry Lynde
Los Angeles, Hoffman Electronics-Parts Sales
Figart's Radio Supply Co.
Radio Products Sales, Inc.
Shelley Radio Co., Inc.
North Hollywood Arrow Sales, Inc.
Honig Distributing Co.
Oakland, Brill Audio Products
Oxnard, Warsco Sales Co.
Paramount, Elwyn W. Ley Co.
Pasadena, Dow Radio, Inc.
Riverside, Electronic Emporium Corp.
Sacramento, Lombard's Electronics
Radio Television Products, Co.
San Carlos, Fortune Electronics
San Diego, Southland Electronics Inc.
San Francisco, Market Radio Supply Co.
West Coast Radio & Electronics
San Jose, Dealer Electronic Corp.
Schad Electronic Supply, Inc.
Santa Ana, Arrow Electronics, Inc.
Seaside, Mat's Electronics Supply
Temple City, G & M Wholesale Electronics
Torrance, Torrance Electronics
West Covina, West Covina Wholesale Electronics
COLO., Denver, Fistell's Electronic Supply Co.
Mountain States Electric Supply
CONN., Hartford, Del Padre Supply of Hartford
D.C., Washington, Electronic Wholesalers, Inc.
FLA., Pensacola, Grice Electronics, Inc.
Tallahassee, Peard Electronic Supply, Inc.
GA., Atlanta, Southeastern Radio Parts Co.
Macon, Peard Electronic Supply, Inc.
ILL., Aurora, Nationwide—W. J. Electronics
Berwyn, Nationwide—W. J. Electronics
B-B & W. Inc.
Champaign, York Radio and Television
Chicago, Allied Radio Corp.
Arthur Nagel Inc.
Bowman Electronic Supply Co.
Nationwide—W. J. Electronics
Philco Dist., Inc.
Forest Park, Allied Radio Corp.
Kankakee, York Radio and Television
Oak Park, Melvin Electronics, Inc.
Skokie, E & H Electrical Distributors
Springfield, York Radio and Television
Waukegan, Nationwide—W. J. Electronics
IND., Evansville, Geo. C. Mettle Co.
Gary, Allied Radio of Indiana
Nationwide—W. J. Electronics
Hammond, Tri-City Electric Co., Inc.
Nationwide—W. J. Electronics
Indianapolis, Graham Electronics Supply
Radio Distributing Co.
Van Sickle Radio Supply Co.
IA., Fort Madison, York Radio and Television
Sioux City, Duke's Radio Co.
Molstad Distributing Co.
Ottumwa, York Radio and Television
LA., Baton Rouge, Davis Electronics Supplies
Lafayette, Electro Technical Labs.
Lake Charles, Wholesale Radio Equipment, Inc.
New Orleans, Walther Bros. Co., Inc.
Radio Parts Inc.
Shreveport, Koelemay Sales Co., Inc.
MASS., Lawrence, Alco Electronics
MD., Baltimore, Revacto of Maryland, Inc.
Silver Spring, Silver Spring Electronic Supply
MICH., Detroit, Electronic Parts Co
MISS., Greenville, Delta Electronics Supplies, Inc
Pascagoula, Mays Electronics Supply
MO., Hannibal, York Radio and Television
Jefferson City, York Radio and Television
Joplin, Russell Belden Electric Co.
Kansas City, Walters Radio Supply, Inc.
NEBR., Omaha, Omaha Electronics Co.
N.H., Laconia, Laconia Electric Co.
Nashua, Gate City Electric Co.
N.Y., Albany, Seiden Sound, Inc.
Binghamton, Stack Electronics, Inc.
Bronx, W. Bergman Co., Inc.
Buffalo, W. Bergman Co., Inc.
Radio Equipment Corp.
Hempstead, Standard Parts Corp.
Rochester, Rochester Radio Supply Co.
Syracuse, Morris Electronics of Syracuse, Inc.
Utica, Associated Electronics Supply
OHIO, Akron, The Sun Radio Co.
Chillicothe, Buckeye Electronics Distributors, Inc.
Columbus, Buckeye Electronics Distributors, Inc.
Whitehead Radio Co.
Coshocton, Wagner's Supply
Dayton, Srepco, Inc.
Stotts-Friedman Co.
East Liverpool, United Electronics, Inc.
Lancaster, Buckeye Electronics Distributors, Inc.
Lima, Hutch & Son
Mansfield, Wholesaling, Inc.
Toledo, Lifetime Electronics
Mainline Dist., Inc.
Warren Radio Co.
Warren, Rem Electronics
Youngstown, Armies Electronics
Glen Electronics
PA., Butler, E and E Supply, Inc.
Erie, Warren Radio, Inc.
Harrisburg, Radio Distributing Co.
Philadelphia, Radio Electric Service Co.
Pittsburgh, Lafayette Radio Electronics
M. Leff Parts Co.
Radio Parts Co.
Tarentum, Huston TV Parts
Wayne, High Fidelity House
TEXAS, Austin, Service Electronic Supply
UTAH, Salt Lake City, Manwill Supply Co.
VA., Portsmouth, Distributors, Inc.
WASH., Seattle, F. B. Connelly Co.
Seattle Radio Supply, Inc.
W. VA., Beckley, Chemcity Electronic Dist., Inc.
WIS., Appleton, Valley Radio Distributors
Fond du Lac, Harris Radio Corp.
Madison, Radio Distributors
Satterfield Electronics, Inc.
Manitowoc, Harris Radio Corp.
Milwaukee, Allied Radio of Wisconsin
Radio Parts Co.
Electronic Enterprises, Inc.
Portage, Satterfield Electronics, Inc.
West Allis, Marsh Radio Supply
Wisconsin Rapids, Satterfield Electronics, Inc.

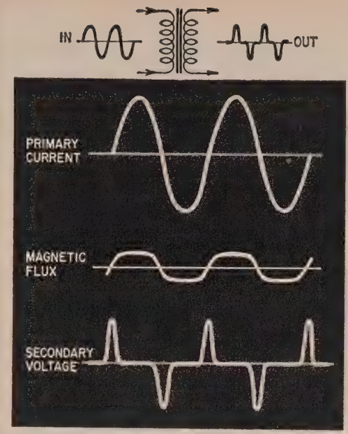


Fig. 18—Peaking transformer saturates at low value of primary current, converting sine wave input to pulse output.

wave input to a narrow pulse output.

Phanotron: Thermionic gas-filled diode.

Phase-controlled rectifier: Rectifier circuit using a thyratron as a rectifying element and a variable-phase sine wave for grid bias. As shown in Fig. 19, the sine wave applied to the grid lags behind the sine wave of plate voltage. As a result, grid voltage returns from its negative excursion during the positive half-cycle of plate voltage. As the grid voltage returns from its negative half-cycle, the bias decreases to the critical value (indicated by the control locus) and the thyratron ionizes. The thyratron now continues to conduct for the remainder of the positive alternation of plate voltage.

If the grid voltage is made to lag the plate voltage by an even greater angle, the grid returns from its negative alternation at a later time during the positive alternation of plate voltage. The thyratron now fires later in the cycle, reducing the conduction time per

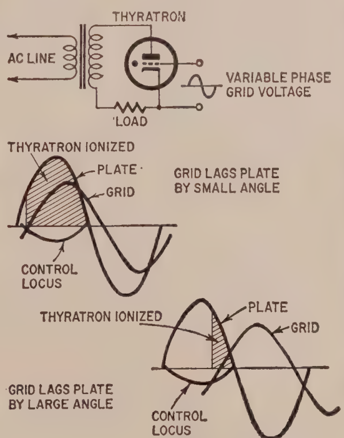


Fig. 19—Grid voltage of phase-controlled rectifier lags behind plate voltage. Angle of lag determines firing point of thyratron.

cycle and the average current through the load. Load current can be varied from its maximum value down to zero simply by varying the phase of the grid voltage. Industrially, the phase-controlled rectifier is used for motor speed control and for delayed firing of ignitron welding circuits (see Back-to-back circuit).

Phase-shifting bridge: Bridge circuit used for varying the phase of the grid voltage in a phase-controlled rectifier. The bridge, shown in Fig. 20, consists of a series combination of resistance

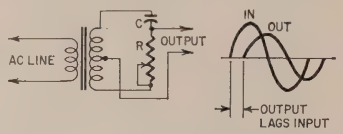


Fig. 20—Phase-shifting bridge produces sine wave output that lags behind input. Angle of lag can be adjusted with a variable resistance.

and capacitance connected across a center-tapped transformer. The sine-wave output of the bridge lags behind the sine-wave input by an angle determined by the values of R and C. The phase of the output voltage can be varied nearly over the entire range of 0° to 180° with the variable resistor. The same effect can be produced by using inductance instead of capacitance in the phase-shifting bridge.

Photoconductive cell: Light-sensitive cell whose resistance decreases with an increase of illumination.

Photoelectric counter: Instrument used for counting objects on a conveyor belt, assembly line, etc. Each object to be counted passes through a light beam and momentarily blocks the illumination to a photo-relay. The relay contacts energize a register: an electromechanical counter consisting of a set of numbered discs like those used to indicate automobile mileage.

Photoelectric cutoff control: Photo-relay circuit used for cutting a long strip of paper, cloth, metal or other material into predetermined lengths or at predetermined positions. Package labels, for example, are printed on a long strip of paper which must then be cut into individual labels. A small *register mark* is printed on each label near the edge of the paper. These register marks are sensed by a phototube as the paper strip passes through the cutting machine. The phototube output is amplified and used to activate the cutting blade. The cutting blade is so positioned with respect to the phototube that it strikes the paper strip between one label and the next.

HERE ARE JUST A FEW OF PACO'S NEWEST KITS:

V-70 VACUUM TUBE VOLTMETER KIT: Employs balanced vacuum tube bridge circuit for all voltage and resistance measurements plus 3-way probe for accurate, rapid test. Includes: 7 DC voltmeter ranges, 7 AC voltmeter ranges (RMS) from 0 to 1500 volts, and 7 AC voltmeter ranges (peak to peak) from 0 to 4000 volts. Also 7 decibel ranges, −6 to +66 db and 7 electronic ohmmeter ranges from 0.2 ohms to 1000 megohms.

V-70 Kit with "Twin-Tested" operating assembly manual ....**$31.95 net**

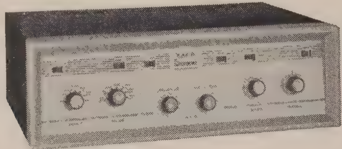
V-70W: Factory-wired ......**$49.95 net**

C-25 IN-CIRCUIT CAPACITOR TESTER KIT: Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Electrolytic Dial.

Simple Sequential Test: reveals open or shorted capacitors, even electrolytics. **Electrolytic Dial:** indicates in-circuit capacity from 2 to 400 mfd: condenser is proved non-shorted and not open if capacity reading can be obtained.

Model C-25 Kit: with Paco-detailed operating assembly manual....**$19.95 net**

Model C-25W: Factory-wired..**$29.95 net**

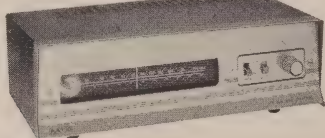


SA-40 STEREO PREAMP-AMPLIFIER: Power: 20W (RMS) per channel, 40W total. Peak, 40W with 80W total. **Response:** 30 cps to 90 Kc, within 1.0 DB. **Distortion:** within 0.5% at 20W per channel. **Includes:** 14 inputs and 14 Panel Controls, black and gold case.

SA-40 Kit with enclosure, "Twin-Tested" operating assembly manual......**$79.95 net**

SA-40W: Factory-wired, ready to operate...........................**$129.95 net**

SA-50: Stereo Kit as above with different styling, 25w per channel..............**TBA***



ST-25 FM TUNER: Sensitivity: 1.5 microvolts for 20 DB quieting. **Harmonic Distortion:** less than 1%. **Includes:** Dual Limiters, AFC and AFC Defeat, "Eye" type tuning indicator, Multiplex jack. Black and gold case or walnut enclosure at slight extra cost.

ST-25 Kit with fully-wired prealigned front end. "Twin-Tested" manual....**$42.95 net**

ST-25W: Factory-wired, ready to operate.............................**$59.95 net**

ST-26 Tuner-Amplifier Kit: Same as ST-25, with built-in amplifier.........**$54.95 net**

ST-26W Tuner-Amplifier: Factory-wired, ready to operate..................**$69.95 net**

DF-90 TRANSISTORIZED DEPTH FINDER KIT: Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Locates hard-to-find schools of fish, too.

Fully Transistorized: 5 transistors, low battery drain for very long battery life.

Fast, Easy Readings: over-sized scale with 1-ft. calibrations from 0-120 ft.

DF-90 Kit: Complete with "Twin-Tested" assembly operating manual..**$84.50 net**

DF-90W: Factory-wired ....**$135.50 net**

G-15 GRID DIP METER: Major Functions: 1-Variable Frequency Oscillator covering 400 Kc up to 250 Mc in 8 bands; 2-Absorption Wavemeter, 400 Kc to 250 Mc; 3-Modulation Indicator. **Applications:** antenna tuning, standing wave checks, neutralizing. TVI suppression, carrier monitoring, etc: RF signal source for visual alignment marking between 400 Kc and 250 Mc. Weighs only 3 lbs.

G-15 Kit: Complete with 8 plug-in coils, "Twin-Tested" manual ......**$31.95 net**

G-15W: Factory-wired ......**$49.95 net**

 ALL PRICES INCL. F.E.T. *Price to be announced

"I built the Paco SA-40 Stereo Preamp Amplifier."

Larry Taylor, 8 Stevens Place, Huntington Station, N. Y. "It took me one-third less time to build the Paco kit than it took Don to make the almost identical preamp-amplifier by another kit maker. But it wasn't just the time; it was knowing you're using the right part, and that you understand the instructions completely. Paco parts are all pictured and labelled, the resistors are neatly mounted on cards for easy identification. And Paco's instruction book doesn't leave you guessing. The fold-out diagrams and drawings are always right beside the instructions, so you're not reading one part of the book and following a diagram in another part. Photographs in Paco's book show how each assembly should actually look. I enjoyed building Paco kits, because I wasn't wasting time or worrying."

(Continued on next page)

INVENTORS OF RADIO

Augusto Righi

By DEXTER S. BARTLETT

AUGUSTO RIGHI WAS A BRILLIANT ITALian basic physicist and educator who sought facts for the sake of science rather than publicity. This has resulted in his being an unknown in this missile age. Both myself and others have diligently sought information on Righi but, with the exception of short biographies, very little information can be found in English. Yet, as a research scientist and educator, he laid much of the foundation for today's electronics as well as other physical sciences. As Guglielmo Marconi was a student at Bologna, while Righi was professor, they became acquainted and Righi was a great help to Marconi, both in encouragement and actual experimentation.

Augusto Righi (sometimes spelled Richi or Rigi) was born in Bologna, Italy, on Aug. 27, 1850. He attended the Bologna University, where he received his diploma. In 1873, he became professor at the Bologna Technical Institute, later to become principal extraordinary at Palermo University where he taught up to the time of his death in 1920. He received many honors and several medals from universities in Italy and elsewhere. In 1872, he was natural science ambassador to the King of Italy. In Rome, he published the results of his theoretical experiments, in 250 scientific papers, embracing almost all subjects in the realm of the physical.

Besides his basic researches in electromagnetic waves, he made two practical contributions to wireless with his oscillator and detector, the basic equipment used in Marconi's first experiments. It was remarked by a veteran engineer that "before describing methods Marconi devised by which he realized his ambition, it is advisable to refer to the work of those pioneers who influenced Marconi in his early experiments, and of whose work he had knowledge: Maxwell, Hertz, Righi and Branly."

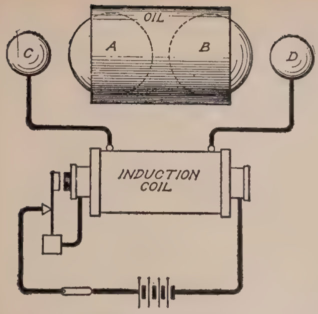
One disadvantage of Hertz' radiator lay in the fact that the sparks in a short time oxidized the little knobs and roughened their surfaces, resulting in irregular action. Professor Righi overcame this difficulty by partly enclosing two metal spheres, A and B in the sketch, in an oil-tight case, the inner hemispheres being immersed in petroleum with only a minute gap between them. In a line with these spheres are ranged two smaller spheres, C and D. It is between A and B in the oil gap that the oscillatory spark takes place, the other two sparks serving merely to charge the large spheres. This arrangement not only produced a more constant spark by preventing pitting electrodes but greatly extended the range of wavelengths which it was possible to employ in investigations of this character. The dimensions of the oscillator could thereby be reduced and the amplitude of the oscillations increased greatly as higher potentials could be reached before the energy was released by discharge. Righi obtained oscillations at 12 kmc by using 8-millimeter spheres for A and B.

He contributed a new "detector" by cutting thin lines on the back of a mirror, dividing the metallic surface with a diamond point into narrow unconnected strips. This provided a spark distance much finer than could be attained by a micrometer gap, as used by Hertz, hence affording greater sensitivity and greatly increasing the distance. Hertz covered only a few meters. The frog's leg, to which we owe the discovery of electric current, had been previously tried by others but had given even poorer results as a detector.

It is a strange coincidence that it took at least 50 years for the electronic industry to go back to centimeter waves. Later researchers added antenna and ground to their oscillators, lowering their frequencies greatly and therefore lengthening the wavelengths.

In his youth, Righi did a great deal of research in the basic relationships between mechanical, electrical and magnetic forces, endeavoring to prove them all of one origin. In this he failed but, considering the status of atomic physics nearly a century ago, this was understandable. However, he did accomplish much in extending Faraday's research on electric and magnetic forces.

Righi did extensive research on the Kerr cell, which is now used in some facsimile systems, and discovered the rotation of the polarization plane with different light frequencies. This in turn led him to the discovery of the photoelectric effect of various materials and then on to work on ionized gases.



Righi's oscillator.

From 1915 to his death, he devoted his researches to the theory of relativity, being one of the few physicists of that day who could understand Einstein's mathematics.

His principal scientific papers were: "The Optics of Electric Oscillations," 1897; "The Motion of Ions in the Electric Discharge," 1903; "Telegraphy without Wires" (in collaboration with B. Dessau), 1903; "The Modern Theory of Physical Phenomena," 1904; "On the Hypothesis of the Electrical Nature of Matter," 1907; "New Views of the Intimate Structure of Matter," 1910; "Radiating Matter and Magnetic Rays," 1910; "The New Physics," 1911; "Ionomagnetic Rotation," 1915; "Electro-Atomic Phenomena under the Action of Magnetism," 1918. END

References:

Enciclopedia Italiana, 1936
Cyclopedia of Applied Electricity, 1911
Florian Cajori, *History of Physics*

What's Your EQ November Solutions

A Current Problem

Both meters read the same current. This is an example of the *reciprocity theorem*, which states:

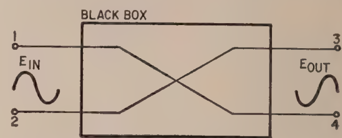
> If an emf of any character located at one point in a linear network produces a current at any other point in the network, the same emf acting at the second point will produce the same current at the first point.

Impossible Voltages

The 30-μf electrolytic capacitor, connected between the arm of the vertical linearity control and chassis, was completely open. This evidently allowed the vertical oscillator and output stage to go into some kind of wild oscillation, at or near the horizontal frequency (it was never exactly traced out) which accounted for the appearance of the high negative voltage at the plate of the output half of the 12BH7.

Black Box Brain Twister

The wires are crossed, from terminal 1 to 4 and from 2 to 3.



NOTEWORTHY CIRCUITS

CRYSTAL DIODE MODULATOR

This crystal-diode modulator enables you to modulate any rf signal up to 1,000 mc with a signal up to 5 mc. Thus, you can modulate a vhf or uhf rf signal generator with a video signal tapped off a TV receiver.

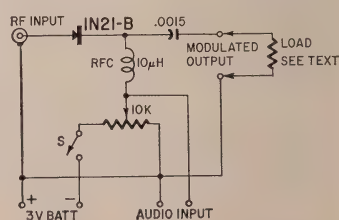
In this circuit, the modulating element is a 1N21-B point-contact crystal diode connected beween the rf input and output terminals. The signal is modulated by superimposing the modulating voltage on the diode's dc bias. The modulating voltage must be much larger than the rf signal. The modulating voltage varies the diodes and thus produces an amplitude-modulated output wave.

The resistance of the output load resistor is determined by the input impedance of the device connected to the output terminals. Use 300 ohms for TV receivers and as high as 1,000 ohms for ordinary radios. The values of the rf choke and capacitor depend on the frequency of the rf signal. I use the values shown on the diagram.

It is a good idea to check the diode modulator on a set that is operating perfectly before using it when aligning a defective set. Listen to the signal on the receiver and set the bias control and adjust the modulating voltage for optimum performance. Record the settings for future reference. You can use a scope to check the modulation pattern at the modulator output. Details on this setup are in most radio and scope handbooks.

The construction of the diode modulator is shown in the photographs. The metal case is 2¾ x 2 x 1⅝ inches. Rf is fed in through a single-conductor mike connector and the modulating signal is fed in through the terminals on top. Modulated rf comes out the terminals on the other end.

The 1N21-B is a high-frequency point-contact diode. It'll probably come in a lead wrapper or container. The large end fits in a clip from a cartridge type fuse holder. A terminal from an old

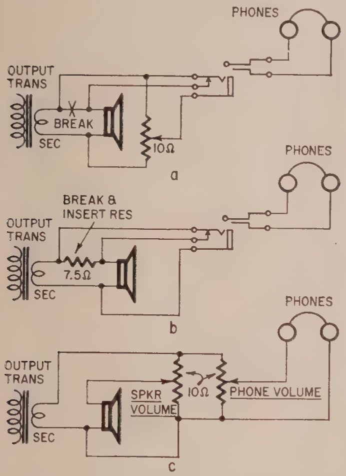


octal socket fits over the other end. When mounting the crystal, ground one hand to the chassis. Otherwise, the diode may be destroyed by a static discharge from your body.—*James A. Fred*

CLOSE-UP TV LISTENING

One family discovered, to their horror, that when the earphone attachment was in use, the TV's speaker was silent. The attachment—a present for a hard-of-hearing grandmother—used a circuit that opened the speaker's voice-coil circuit. See circuit *a* in the illustration.

A 7.5-ohm fusible resistor that I carried in the tube caddy saved the day. It restored speaker volume when connected as at *b*. Circuit *c* is an improvement that allows independent control



of speaker and earphone volume.—*E .C. Carlson* END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In December, 1911, *Modern Electrics*

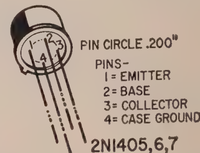
The Fessenden Interference Preventer, by Eberhardt Rechtin.
Selenium and Its Extraordinary Characteristics, by Charles Proner.
Using Telephone Receivers Without Detectors.
Radar in 1911, (forecast) by H. Gernsback.
A Variable Mercury Condenser.
Improved Transmitter for Wireless Telephony.
An Inductance or Loading Coil, by R. S. Crawford.

NEW TUBES and SEMI-CONDUCTORS

TUBES ARE OUTNUMBERED THIS MONTH by a wealth of interesting semiconductors. There's a reflex amplifier, uhf units with a maximum frequency of 1,110 mc and some high-speed switching transistors. On the tube side you'll find a group of horizontal deflection amplifiers in Novar envelopes.

2N1405, 2N1406, 2N1407

A group of uhf p-n-p transistors made by gaseous diffusion. They are intended for reliable operation in rf applications in the vhf–uhf ranges. Maximum frequencies for these units are 1,100 mc—2N1405; 750 mc—2N1406, and 650 mc—2N1407.



Maximum ratings for these Texas Instruments transistors at 25°C are:

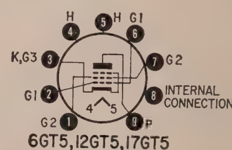
V_{CB}	30
V_{EC}	20
V_{EB}	1
I_C (ma)	50
P_{total} (mw)	75

Electrical characteristics are:

	2N1405	-06	-07
h_{fe} ($V_{CE}=-6$, $I_C=2$ ma, f=100 mc)	10	10	7.5
NF ($V_{CB}=-6$, $I_E=2$ ma, f=200 mc, $R_g=$ 75 ohms	5 db	6 db	7 db

6GT5, 12GT5, 17GT5

These RCA high-perveance single-ended beam power tubes in a Novar envelope are designed for use as horizontal deflection amplifiers in TV receivers. Except for heater ratings, the tubes are identical electrically. The 6GT5 heater is rated at 6.3 volts 1.2 amperes; the 12GT5, 12.6 volts at 600 ma; the 17GT5, 16.8 volts at 450 ma. The 12GT5 and 17GT5 have a controlled warmup time of 11 seconds.



6GT5,12GT5,17GT5

Maximum ratings in horizontal deflection amplifier service:

V_P (boost plus dc power supply)	770
(peak positive pulse)	6,500
(peak negative pulse)	1,500
I_K (peak ma)	550
(average ma)	175
$G2_{input}$ (watts)	3.5
P_P (watts)	17.5

2N1864

A hermetically sealed p-n-p germanium micro alloy diffused-base transistor designed for use as a reflex amplifier in broadcast receivers. It provides high gain at both audio and 455-kc frequencies, eliminating the need for

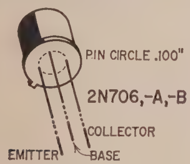
an additional audio frequency amplifier in portable radios.

Maximum ratings of the Philco 2N1864 are:

V_{CB}	20
V_{CES}	20
V_{EB}	0.5
I_C (ma)	50
P_{total} (mw)	60

2N706, -A, -B

A series of n-p-n silicon Planar transistors designed for high-speed switching and high-frequency amplifier service. The transistors are useful in nanosecond switching circuits and hf and vhf tuned amplifiers.



Maximum ratings of these General Instrument semiconductors are:

	2N706	-706-B	-706-A
V_{CBO}	25	25	25
V_{EBO}	3	5	5
V_{CER} (10-ohm resistor from base to emitter)	20	20	20
P_{total} (mw)	300	300	300

2N511, -A, -B

This group of p-n-p alloy-junction germanium transistors is designed for high-power applications. With their 150-watt dissipation, they are especially useful in high-power conversion, high-current switching and audio amplifier output stages.

Maximum ratings for these Texas Instruments transistors at 25°C are:

I_C (amps)	25
I_B (amps)	5
P_{total} (watts)	150

Maximum voltage ratings are not specified because exceeding breakdown voltages will not permanently damage

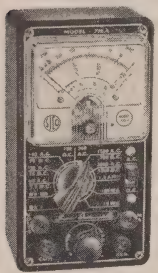
(*Continued on page* 106)

EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship at our risk one or more of the testers described on these pages.

SUPERIOR'S NEW MODEL 770-A

VOLT-OHM MILLIAMMETER



FEATURES:

- Compact—measures 3⅛" x 5⅞" x 2¼".
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-cornered, molded case.

SPECIFICATIONS:

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts.

6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.

2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.

3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps.

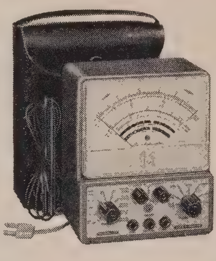
3 DECIBEL RANGES: —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL VIEW METER



SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.
All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

Model 79 comes complete with operating instructions, test leads and carrying case. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price!

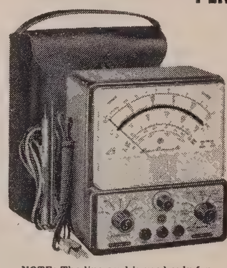
SPECIFICATIONS:

- **DC VOLTS**—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2000 volts.
- **ELECTRONIC OHMMETER**—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- **DECIBELS**—10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).
- **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER



6 INCH FULL-VIEW METER provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

MIRRORED SCALE permits fine accurate measurements where fractional readings are important.

SPECIFICATIONS:

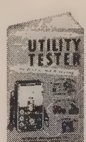
7 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
6 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500 Volts.
3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms. 0-20 Megohms.
2 CAPACITY RANGES: .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
5 D.C. CURRENT RANGES: 0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 DECIBEL RANGES: —6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 70 UTILITY TESTER

FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS ★ AUTOMOBILES



INCLUDED FREE

64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.

As an electrical trouble shooter the Model 70:
• Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc. • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

As an Automotive Tester the Model 70 will test:
• Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

DID YOU EVER?

- Order merchandise by mail, including deposit or payment in full, then wait and write... wait and write?
- Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

Obviously prompt shipment and attention to orders is an essential requirement in our business... We ship at our risk!

NO

CONTRACT TO SIGN

CO-MAKERS

EMPLOYER NOTIFICATION

The simple order authorization included in this offer is *all* you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

EXAMINE ANY ITEM YOU SELECT IN THE PRIVACY OF YOUR OWN HOME

Then if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

SUPERIOR'S NEW MODEL 82A

MULTI-SOCKET TYPE TUBE TESTER

SPECIFICATIONS:

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable case.
Price is $36.50. Terms: $6.50 after 10 day trial then $6.00 monthly for 5 months.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large-easy-to-read type.
- **NOISE TEST:** Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.
- **SEPARATE SCALE FOR LOW-CURRENT TUBES**—Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 83A

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES
Test ALL picture tubes —in the carton —out of the carton —in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.

Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

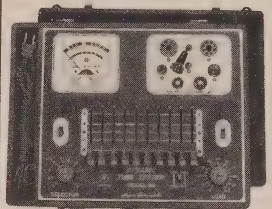
Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 85

TRANS-CONDUCTANCE TYPE TUBE TESTER

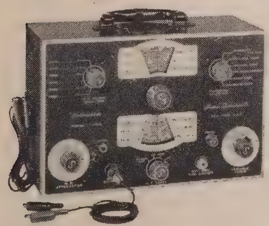


- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **SYMBOL REFERENCES:** Model 85 employs time-saving symbols (*, +, ●, ▲, ■:) in place of difficult-to-remember letters previously used. Repeated time-studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.
- **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.
- **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers *at no charge* for a period of five years after date of purchase.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. **Price is $52.50. Terms: $12.50 after 10 day trial then $8.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER
7 Signal Generators in One!



- R.F. Signal Generator for A.M.
- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Bar Generator
- Cross Hatch Generator
- Color Dot Pattern Generator
- Marker Generator

A versatile all-inclusive **GENERATOR** which provides **ALL** the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 88

TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS

AS A TRANSISTOR RADIO TESTER

An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

AS A TRANSISTOR TESTER

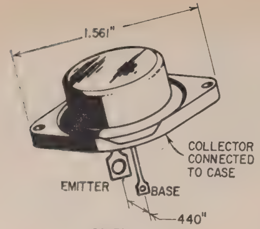
The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete —nothing else to buy! **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SEND POSTCARD TODAY (NO POSTAGE NECESSARY)

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC., DEPT D-915 3849 TENTH AVENUE, NEW YORK 34, N.Y.



2N511,-A,-B

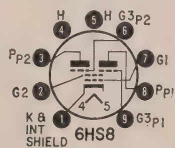
(*Continued from page* 101)
transistor characteristics if other maximum ratings are not exceeded.

Electrical characteristics at 25°C:

	2N511	-11-A	-11-B
BV_{CBO} (I_C = 5 ma, I_E = 0)	40	60	80
BV_{CEO} (I_C = 500 ma, I_C = 0)	30	40	45
BV_{CES} (I_C = 300 ma, V_{BE} = 0)	50	60	65
BV_{EBO} (I_E = 5ma, I_C = 0)	30	30	30

6HS8

A sharp-cutoff twin pentode of the 9-pin miniature type having a common cathode, grid No. 1 and grid No. 2. In addition G1 and G3 have separate pin connections so either can be used independently as a control electrode. The 6HS8 is designed for use in agc amplifier, sync, and noise-limiting circuits of TV receivers. In such circuits,



one pentode performs the function of combined sync separator and sync clipper. The other unit serves as an agc amplifier.

Characteristics of the RCA 6HS8 as a class A1 amplifier with both units operating are:

V_P (each unit)	100	100
V_{G3} (each unit)	—10	0
V_{G2}	67.5	67.5
V_{G1}	adjusted for I_{G1} 100 μa	
I_P (Each unit) (ma)	—	2
I_{G2} (ma)	7	4.4
I_K (ma)	7.1	8.5

2N960, -61, -62, -64, -65, -66

A string of p-n-p epitaxial switching transistors designed by Motorola for ultra-high-speed applications.

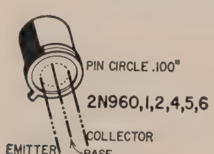
Maximum ratings are:

	2N290	-61	-62	-64	-65	-66
V_{CB}	15	12	12	15	12	12
V_{CE}	15	12	12	15	12	12
V_{EB}	2.5	2	1	2.5	2	1
P_{total} (mw)	300	300	300	300	300	300

Electrical characteristics at 25°C:

h_{FE} (I_C=—10 ma, V_{CE}=1 v) (typical)	55	55	55	95	95	95
t_{on} (nsecs)	35	35	35	35	35	35
t_{off}	60	60	80	80	60	60

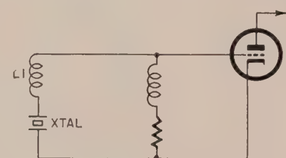
END



USING DEFECTIVE CRYSTALS

Many experimenters and amateurs have either thrown away or stored in the junkbox defective quartz crystals. Very few take advantage of the fact that crystals can usually be made to oscillate by introducing a small amount of regeneration.

If the crystal is merely inactive, it will probably work by using this scheme. If the crystal is cracked, the



fracture should be carefully broken through and its edges flattened. Then round the corners on a fine carborundum stone. Be careful when using the carborundum stone to avoid scratching the crystal surface.

Experiments with dozens of crystals have shown that the final shape and size is unimportant. It is possible to get several good crystals from an inch-square plate in this manner, although not all crystals will oscillate on the original frequency.

For 80-meter crystals, coil L1 in the diagram may be 5 to 30 turns of No. 20 wire on a 1½-inch-diameter form. About half the number of turns is right for 40-meter crystals.—*Alvin G. Sydnor*

IMPROVING RECEIVER AND AMPLIFIER PERFORMANCE

Many amplifiers and radio receivers more than a year old can be improved by tightening grounds and other connections on the chassis.

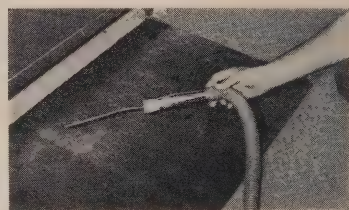
In nearly every amplifier and receiver, dozens of bypass capacitors and resistors are grounded to the chassis by lugs and nut-and-bolt connections. The connections between the lug and chassis become oxidized in time, increasing the resistance of the connection. In effect, this places resistors in the circuit where they do not belong.

While the effect of such an added resistor in series with a resistor would ordinarily be negligible, it is another matter in the case of a capacitor. The cumulative effect of many such resistors in series with a similar number of capacitors will result in lowered sensitivity, instability, alignment shift and other faults.

This effect can usually be eliminated completely by tightening all screws from the top of the chassis. Even when screws are already tight, the slight movement will erase oxidation.—*Warren J. Smith*

HANDY TOOL

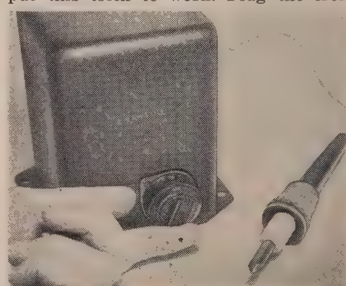
A useful shop aid for extracting dust or small components from cramped locations is a piece of soft copper tubing poked through a snug-fitting hole in a wood spool. Grind the outside of the spool down to make a tight fit in the



nozzle end of the hose on a vacuum cleaner. It's also useful for picking up stray bits of solder or other metal parts that have lodged in or around circuitry and components.—*Harry J. Miller*

SOLDERING IRON ON STANDBY

Those who have to let a hot soldering iron or pencil stand idle on the bench for considerable periods of time should put this trick to work. Plug the iron



into a variable isolation transformer such as the Stancor IS-100 shown. The transformer's variable output lets the iron stand idle at low heat, and lets you quickly boost it back to full heat the moment it's needed. This reduces tip oxidation and frequent cleaning and tinning.—*John A. Comstock* END

New Sylvania Technique eliminates erratic pin soldering

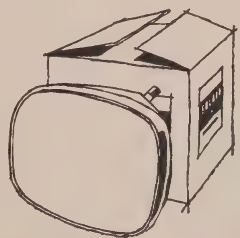
Picture tube callbacks due to "open-pin connections" dramatically reduced

The "old" conventional pin soldering method relied upon contact between pin and wire only at their tips.

New Sylvania pin soldering technique extends solder far up into the pins—provides maximum contact with the wire—assures low electrical resistance and high mechanical strength.

What does the new Sylvania pin soldering technique mean to you? It means the solution of a long-standing, industry-wide pin soldering problem. Callbacks will be reduced—crimping and resoldering will be a thing of the past.

Thousands of service technicians have proven for themselves—in millions of service calls—that Sylvania SILVER SCREEN 85 TV PICTURE TUBES are the surest way to build a better business. You should, too. Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.



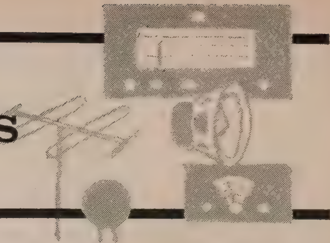
SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

NEW PRODUCTS



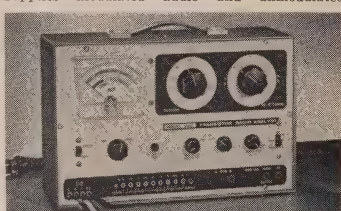
TUBE TESTER for all new tube types, all TV and radio tubes. *Model 648S* (illus) has 23 separate heater voltages from 0.75 to 117. Uses quick variable-sensitivity short test up to 2

megohms. *Model 658A* for industrial, lab and engineering applications makes heater continuity, heater current, rectifier, Dynamic "Eye" tube and grid-leakage tests on old and new tube types.—**Jackson Electrical Instrument Co.**, 124 McDonough St., Dayton, Ohio.

TV SWEEP CIRCUIT ANALYZER, *model S117.* Uses signal injection plus direct component substitution for testing circuits with set turned on. Checks horizontal oscillator, output, deflection yoke, output transformer, and vertical deflection

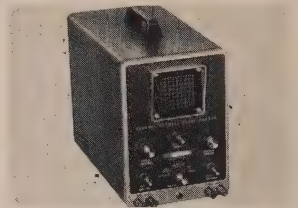
yoke and second anode voltage. External circuit measurements 0–300 and 0–1,000 volts dc for checking B-plus and boost volts; 0–300 and 0–1,000 volts peak to peak for checking sync and oscillator outputs, 0–300 ma dc for checking current through B-plus fuse.—**Sencore Inc.**, 426 Westgate Drive, Addison, Ill.

TRANSISTOR RADIO ANALYST, *model 960.* Includes sig gen, power supply, vtvm, milliammeter, in- and out-of-circuit transistor tester. Supplies modulated audio and unmodulated



signals. Separate low-impedance audio output for signal injection into speaker voice coils. 117 volts, 50–60 cycles ac.—**B&K Mfg. Co.**, 1801 W. Belle Plaine, Chicago, Ill.

3" OSCILLOSCOPE. Kit *model IO-21.* Identical vertical and horizontal amplifiers, frequency response ±2 db from 2 cycles to 200 kc, sensitivity 0.25 volt rms/inch peak-to-peak deflection at 1 kc with input impedance 10 meg shunted by 20 $\mu\mu$f. Sweep gen 20 to 100,000 cycles in 4 ranges with automatic sync and retrace blanking. 3RP1 C-R tube with neck shield to minimize effects of extraneous field. Focus and



astigmatism controls for sharp trace; power supply fused for protection.—**Heath Co.**, Benton Harbor, Mich.

TUBE TESTER, *model 1100.* Checks all tubes including nuvistors, Compactrons, Novars, 10-pin types; also battery tubes, auto radio hybrids, voltage regulators, foreign, hi-fi, thyratrons and

industrial tubes. Tests for dynamic cathode emission, shorts and leakage, grid leakage and gas content.—**Mercury Electronics Corp.**, 111 Roosevelt Ave., Mineola, N. Y.

IN-CIRCUIT CAPACITOR TESTER, *model IC-60.* Isolates troubles due to faulty capacitors without disconnecting them. Clear readings on indicator for all open or shorted capacitors, including

electrolytics. Open test provides open-circuit test for capacitors low as 5 μf; short test shows shorted capacitors with circuit shunting resistance as low as 10 ohms.—**Precision Apparatus Co., Inc.**, 70-31 84th St., Glendale 27, N. Y.

CAP-POT POTENTIOMETER, *series 60M.* Electrical element in knob, which also serves as moisture- and dustproof housing. Terminals sealed, brought out through rear of mounting

bushing. Resistance range 10 to 10,000 ohms, wirewound, rated ½ watt at 40°C. Linear taper. Resistance tolerance 10%.—**Clarostat Mfg. Co., Inc.**, Dover, N.H.

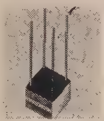
CAPACITORS, tubular sintered anode tanta-

lum *Model TAK-H* operates at temperatures from −55°C to +125°C at 70 volts without voltage derating; *TAK-C* from −55°C to +100°C at 85 volts; *TAK* from −55°C to +85°C. *TAK* operates up to 125°C by derating working voltage. All units withstand low-frequency vibration tests to MIL-STB-202 and high-frequency at 15G from 10 to 2,000 cycles without intermittent contacts, opens, short circuits or mechanical damage.—**General Instrument Capacitor Div., Orange Street, Darlington, S.C.**

SELENIUM RECTIFIERS with power capacities up to 250 va. Conduction-cooled, epoxy-sealed. Half-wave, doubler and bridge configurations in single-phase or 3-phase circuits,

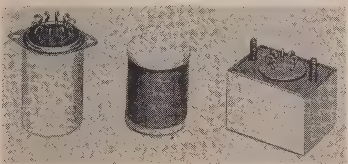
single package for up to 130-volts rms input, current outputs to 10 amps dc.—**Radio Receptor Co., Inc., 240 Wythe Ave., Brooklyn 11, N.Y.**

MINIATURE TRANSFORMERS. Weldable leads for high-reliability welded connections in hi-density electronic assemblies. Gold-plated nickel-



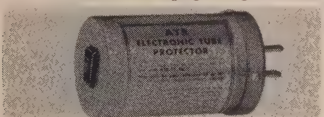
iron alloy lead wire for superior weld joints.—**Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.**

TRANSFORMER takes 11.6-volt rms, 3-phase input. Output 11.6 volts rms 2-phase. Scott transformer encased in hermetically sealed metal



container. Leads terminated by 7-pin, hermetically sealed glass header.—**Supreme Transformer Co., 3911 S. Michigan Ave., Chicago, Ill.**

ELECTRONIC TUBE PROTECTOR *model 250* eliminates initial damaging surge currents.



Wall or floor models, for equipment drawing 100 to 300 watts.—**ATR Electronics, Inc., 300 E. 4 St., St. Paul 1, Minn.**

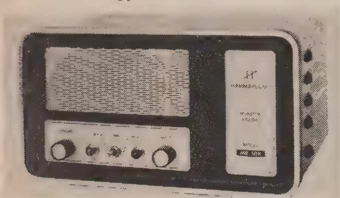
ELECTRONIC CHEMICALS in 16.4-oz spray cans. *Sargent* line features Red Insulator, tuner cleaner, gear and parts cleaner. Degreaser, clear

acrylic plastic, penetrating oil, squeak stopper, enamels, lacquers, metallics, engine enamels.—**Sargent-Gerke Co., PO Box 729, Indianapolis 6, Ind.**

SOLDERING IRON, *Penline-120,* for maintenance, repair, lab use and kit building. 120-volt unit has 30- and 50-watt integral tip-heater

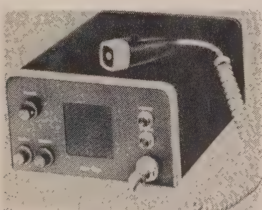
assemblies for maximum heat and fast temperature recovery. 30-watt rating with 3/16- or 9/32-inch chisel tips; 50-watt with ⅜-inch chisel tip.—**General Electric Co.**, Schenectady 5, N. Y.

MONITOR RECEIVERS, *Models MR 30X* and *MR 50X*. Crystal-controlled split-channel instruments for remote monitoring of two-way communications. Supplied tuned to any predetermined channel; optional channel selector for selection of up to 4 channels. Built-in whip antenna, external antenna connects when necessary. 117 volts ac. *MR 30X* for 25 to 54 mc, *MR 50X* for 147 to 174 mc.—**Hammarlund Mfg. Co.**, 460 W. 34th St., New York, N. Y.



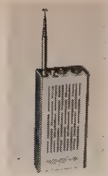
MINIATURE 2-WAY CB TRANSCEIVER *Personal Messenger*. Battery-powered, contains 11 transistors and 4 diodes. Superhet receiver, rf amplifier, 2-stage transmitter, moisture-resistant speaker/microphone, socket type battery contacts.—**E. F. Johnson Co.**, Waseca, Minn.

CB RADIO, *model Hi-104*. Range up to 25 miles, power consumption 5.5 amps on 12 volts dc, or 55 watts on 115 volts ac. Harness-type wiring, single crystal per channel for transmitting and receiving.—**Hallmark Instruments Corp.**, 2215 Commerce St., Dallas, Tex.



MINIATURE CB RADIO, *model CT-200*. Transistor transmitter and receiver operate in pairs or with existing mobile and base equipment. Power from standard 9-volt dry batteries or rechargeable nickel-cadmium batteries. Press-to-talk switch and 8-section antenna.—**Polytran Industries, Inc.**, 1010 Howard Ave., San Mateo, Calif.

9-TRANSISTOR CB TRANSCEIVER, *model GW-21*, kit or assembled. Crystal-controlled superhet receiver. Rf amplifier, squelch and noise limiter, 1-μv sensitivity for 10 db S/N ratio. Transmitter section; crystal-controlled oscillator, driver stage and modulated rf output amplifier. Maximum power input to final, 100 mw. For use without license, or for licensed operation with class-D CB stations.—**Heath Co.**, Benton Harbor, Mich.

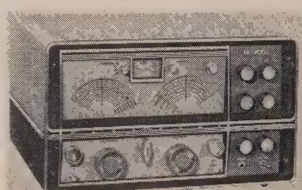


VFO, *model 722*. Full coverage 80–10-meter. Anti-backlash tuning, low-heat silicon-diode doubler power supply, buffer–multiplier output stage, slide-rule dial. Electron-coupled, series-tuned, 1⅜-inch air-core coil, temperature-compensating capacitors. High L-C ratio reduces drift.—**EICO (Electronic Instrument Co. Inc.)**, 33-00 Northern Blvd., Long Island City, N. Y.

MULTIPLEXER ANTENNA. Frequency specified upon order, gamma-tuned 72-ohm 3-, 5- and 10-ohm built-in coax connector and Quick-rig construction.—**Taco**, Box 38, Sherburne, N. Y.

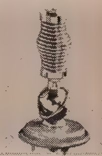
TRANSISTOR MULTIPLEX ADAPTER, *model 611*. Converts conventional FM tuners or receivers to stereo. *ABCO* contains 4 transistors; separation 20 db from 30 to 15,000 cycles.—**ABC Electronics, Inc.**, 611 Brookhaven Dr., Orlando, Fla.

MULTIPLE CRYSTAL ADAPTER, *model MX-400* for NC-400 general communications receiver. Allows selection of up to 50 crystal-controlled channels, assures fixed channel reception. Factory-installed.—**National Radio Co.**, 61 Sherman St., Melrose, Mass.

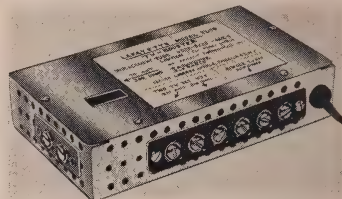


PA AMPLIFIER, *model 7061*. Hi-fi circuitry throughout. Full-range controls with 20–20,000-cycle response. 2 mike inputs with independent volume controls. Circuits for mixing either or both mikes with phono input or tuner. Monitor output feeds external amplifier. Rated output 17 watts—34 watts peak; mike gain 120 db, phono 85 db; hum and noise level 65 db below rated output, output impedances 4–8–16–500 ohms (70-volt line).—**Eric Electronic Corp.**, 1823 Colorado Ave., Santa Monica, Calif.

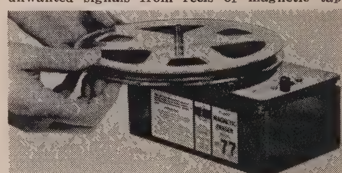
ANTENNA BASE, *model NTS-1*. Swivel ball, spring mount and all exposed metal fittings of stainless steel. Light weight reduces flexing of vehicle panel. Spring assembly features double capture design and reduced length.—**New-Tronics Division**, 3455 Vega Ave., Cleveland, Ohio.



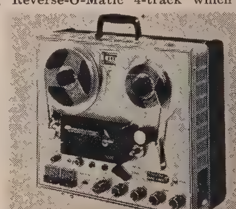
TV/FM BOOSTER–COUPLER, *model TL-75*. 4-set amplifier for signal amplification in fringe locations. Requires no tuning. Screw type antenna terminals eliminate special stripping of transmission line. Isolation circuit prevents interaction and interference between sets. 117 volts ac 60 cycles.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.



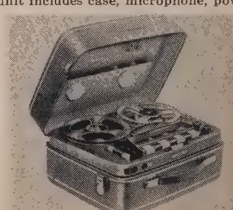
BULK TAPE ERASER, *model ME-77*. Removes unwanted signals from reels of magnetic tape up to 7 inches in diameter, demagnetizes ¼-inch tape in seconds. Erases all tracks simultaneously. *Model ME-99*, professional size.—**Robins Industries Corp.**, 36-27 Prince St., Flushing 54, N. Y.



TAPE RECORDER, *model S505*. 2-track recorder, Reverse-O-Matic 4-track which reverses automatically, or other configurations. Stainless steel; black knobs, meters and hardware.—**American Concertone Inc.**, 9449 W. Jefferson Blvd., Culver City, Calif.

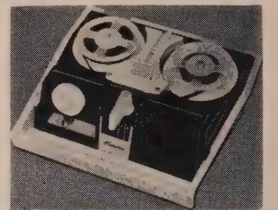


TAPE RECORDER. *Korting MT-136*. 2-track mono unit includes case, microphone, power cable,



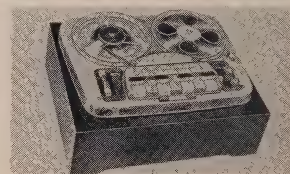
diode connection cable and empty tape reel. Tape-position indicator for forward and rewind; recording-level indicator; switchable input for microphone and radio; separate bass and treble controls; mixer pushbutton. Standard 110–120 volts ac, two speeds, response is 30–16,000 cycles at 3¾ ips and 30–20,000 cycles at 7½ ips; wow and flutter 0.2% at 7½ ips, 0.35% at 3¾ ips.—**Kimberly Industries Ltd.**, 346 W. 44th St., New York, N. Y.

ALL-TRANSISTOR TAPE RECORDER. Single control for rewind, off, play, record. Crystal



mike, built-in Alnico V dynamic speaker. 2 size-D and one 9-volt transistor battery.—**Edmund Scientific Co.**, Barrington, N. J.

TAPE RECORDER DECK, *Korting model 114.* 4-track stereo unit. Separate heads for record, playback, erase. Preamp equalizer for recording and playback, allowing use with external power amp only. For mono recording or playback, internal preamp equalizer may be bypassed to



use external preamp equalizer. Dubbing control dubs previous recording simultaneously onto recording track, producing multiple-synchronized recording. Response 40–15,000 cycles at 3¾ ips; 30–20,000 cycles at 7½ ips. Wow and flutter less than 0.2% at 7½ ips.—**Kimberly Industries, Ltd.**, 346 W. 44th St., New York, N. Y.

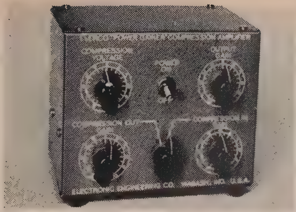
TAPE CARTRIDGE PLAYER, *model 36.* Solenoid-actuated start and stop operation. Remote control operated manually or by external switching electronics actuated by tone pulse or

tape contactor head. Standard head bracket for 3 heads. Full-, hal- or quarter-track heads. Tape speeds of 1⅞, 3¾ and 7½. *Model 37* same with automatic cartridge lock-in reject mechanism for rapid handling of cartridges.—**Viking of Minneapolis, Inc.**, 9600 Aldrich Ave. So., Minneapolis, Minn.

TURNTABLE–ARM COMBINATION. 33-1/3-rpm. Arm, walnut base, dust cover, cables, overhang adjustment device and needle force gauge.

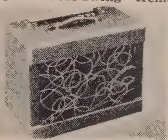
Belt drive from synchronous motor, 3.5-lb. aluminum platter, shock mountings from top plate. Tone arm floats down to record if dropped, damping mechanism disengaged when needle touches record.—**Acoustic Research, Inc.**, 24 Thorndike St., Cambridge 41, Mass.

AUDIO COMPRESSION AMPLIFIER *Power Gainer* increases effective range of 2-way radio, amplifies low-level sounds to level equal to low-



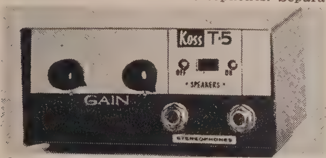
frequency voice sounds. For base-station or mobile applications.—**Blenco, Electronic Engineering Co.**, Wabash, Ind.

PORTABLE AMPLIFIER, *model PA-273WX*. 5 dual-purpose tubes and 12-inch speaker deliver 15 watts output. Wide-swing tremolo control



foot-operable. 3 separate accordion, guitar and instrument output jacks. Tube complement: 1-12AX7, 1-12AU7, 2-7189, 1-6CA4.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

HI-FI HEADPHONE JUNCTION BOX, *model T-5*. Inputs for 2 sets of Stereophones. Separate



volume controls for left and right ears. Remote-control volume level plus on–off speaker switch.—**Koss Electronics, Inc.**, 2227 W. 31st St., Milwaukee 8, Wis.

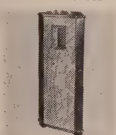
EARPHONES, Feather-Lite series. Plastic cone. Lightweight, flexible headbands. Monaural types, 8 and 100 ohms; stereo, 16/16 ohms. Also with

boom-mounted mike, impedances 50, 100 and 200 ohms dynamic, 200 and 16,000 ohms magnetic, ceramic and crystal for high impedance.—**Permoflux Corp.**, 4101 San Fernando Rd., Glendale 4, Calif.

AUDIO ADAPTER, *model 373*. Converts binding post, screw- or solder-type terminals on stereo hi-fi amplifiers, tuner, speakers, record

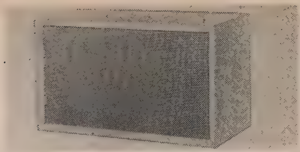
players and turntables to phono jack terminations. 2-conductor long-handle phone jack connected to 3-inch shielded cable.—**Switchcraft, Inc.**, 5555 No. Elston Ave., Chicago 30, Ill.

HI-FI SPEAKER SYSTEM, *DuK-60*. 4 reproducers and 2 crossover controls make up columnar system. Ionovac tweeter covers 3,000 to



30,000 cycles; 8-inch speaker for mid-range frequencies, 12- and 8-inch woofers for low frequencies.—**Dukane Corp., Ionovac Div.**, St. Charles, Ill.

SPEAKER SYSTEMS AND CABINETS, *Mark I* for medium- and low-level reproduction. Houses 8-inch speaker, 1-inch voice coil. 8 ohms impedance. Cabinet 11 x 9½ x 23 in. Response

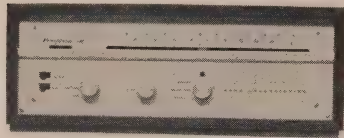


45 to 13,000 cycles. *Mark II* has 12-in. coaxial speaker with 6.3 oz. Alnico V magnet, 1-inch voice coil, one-piece cone, 3-inch Alnico V PM tweeter. Power rating 12 watts, impedance 8 ohms. Cabinet 14 x 11½ x 23¾ in. Response 50 to 15,000 cycles.—**Cabinet Acoustical Engineering Corp.**, Haledon, N. J.

THIN SPEAKER, *Wafaire Bi-Phonic Coupler.* Large panel section vibrates as single piston. Unbaffled, free unrestricted radiation on both

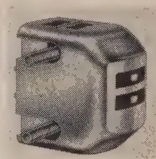
sides, produces double-sided, figure-8 radiation pattern, adaptable to stereo. 30 cycles to beyond audible range. 13½ x 21¾ x 3⅜ inches.—**Advanced Acoustics Co.,** 67 Factory Place, Cedar Grove, N. J.

STEREO-EQUIPPED TUNER, *model SCT-4.* Variable FM tuner has built-in Magic Module stereo system. Receives composite stereo signal,



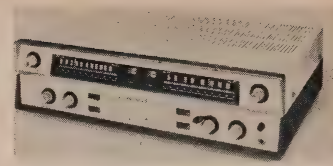
sends left and right signals through amplifiers and speakers. Sidebands carefully preserved to retain maximum stereo effect.—**Karg Laboratories, Inc.,** 162 Ely Ave., S. Norwalk, Conn.

TAPERED HEAD, *model 5QT17.* 4-track stereo record and playback head. Tapered profile sim-



plifies insertion of cartridge tape by eliminating corners.—**Michigan Magnetics, Inc.,** Vermontville, Mich.

STEREO RECEIVER, *model KW-60.* Built-in

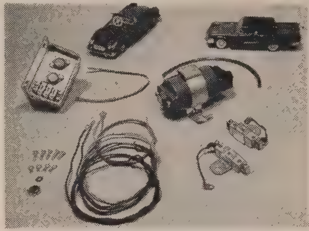


multiplex adapter. Tuning ranges: FM, 88–108 mc; AM, 535–1605 kc. Sensitivity: FM, 2 μv/98 mc; AM, 40 μv/1000 kc. Tone control 50 cycles, +15 db, −14 db; 10 kc, +15 db, −17 db. Output 30 watts per channel. Multiplex stereo circuit; FM, AFC; whistle, rumble and scratch filter; stereo phone jack.—**American Commercial Inc.,** 212 Fifth Ave., New York 10, N. Y.

PHASE COORDINATOR checks balance and phase relations of speaker output of stereo

system. Direct-reading meter clearly indicates correct setting.—**Stereosonics, Inc.**, 39–43 46th St., Long Island City 4, N. Y.

ELECTRONIC IGNITION SYSTEM *model TS-14* for auto, truck, tractor, boat, bus or race car. All-transistor system gives improved acceleration, maximum high-speed performance,



constant engine timing, greater road horsepower, smoother idling, longer spark plug life. Installs in 20 minutes.—**Bill Slep Co**, PO Box 178, Ellenton, Fla.

All specifications are from manufacturers' data

NEW LITERATURE

CATALOGS • BOOKLETS • CHARTS

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

EQUIPMENT CATALOG shows line of electronic kits, assembled items and separate components. Hi-fi gear, test equipment, and educational kits are included. All items photographed, with full description and specifications.—**Heathkit**, Benton Harbor, Mich.

ELECTRICAL WIRING DEVICES, lamps and specialty products are illustrated in 96-page 2-color catalog. Full information is given on over 1,500 items, including switches and receptacles, transformer, extension and cord sets, fuses, etc. Indexed to facilitate easy reference by contractors, architects, consulting engineers and dealers. —**Eagle Electric Manufacturing Co., Inc.** 23-10 Bridge Plaza South, Long Island City 1, N.Y.

COMPONENT CATALOG 100 gives detailed specifications and prices for Centralab line of controls, switches, ceramic capacitors, and packaged circuits. Kits are also included.—**Centralab** Electronics Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

DC POWER SUPPLIES for all low-voltage dc applications are shown in a new 5-page booklet. Included are photos of eight models, with specs and applications.—**Electro Products Labs**, 4501 N. Ravenswood Ave., Chicago, Ill.

AUDIO ACCESSORIES are described in 12-page *Catalog A-401*. Audio mixers, miniature transistor amplifier, 4-channel mixers, stereo and monaural switches, speaker volume controls, interconnecting cords, adapters and connectors are among the 300 items listed.—**Switchcraft, Inc.**, 5555 N. Elston Ave., Chicago 30, Ill.

GLASS, PLASTIC AND CERAMIC CAPACITORS are described in 16-page *Bulletin 314-3*. Glass trimmer capacitors, operating from −55°C to +125°C at 1,000 working volts dc, available in panel or printed circuit mount, are featured. —**Erie Electronics Div., Erie Resistor Corp.**, 644 West 12th St., Erie, Pa.

QUARTZ CRYSTALS for all uses are presented in illustrated catalog and price list 961. This booklet includes diagrams of oscillator circuits, various types of crystals, such as low-frequency, CB, amateur, plated and pressure type, as well as history and facts on their manufacture and use.—**Texas Crystals**, Dept. N, 1000 Crystal Drive, Fort Myers, Fla.

HIGH-BAND ADDITION SYSTEM featuring automatic level control is presented in supplement to *Catalog F-1113*. Accompanying sheets illustrate a variety of bridging amplifiers.—**Entron, Inc.** 4902 Lawrence St., Box 287, Bladensburg, Md.

ELECTRIC PRODUCTS are presented in 400-page illustrated *Catalog FR-62*. GC Electronics line of chemicals, tools, hardware, plugs, jacks, knobs, test equipment, CB supplies, antennas, phono drives, stereo accessories and microphones fully described.—**GC Electronics Co.**, Rockford, Ill.

PA AMPLIFIERS, TELEPHONE INTERCOM SYSTEMS shown in two new catalogs. Photos, descriptions and specs of 10 amplifiers, systems and accessories, as well as 15 intercom systems. —**Mark Simpson Mfg. Co. Inc.**, 439 Frelinghusen Ave., Newark 12, N.J.

TB KNOB REFERENCE GUIDE lists more than 3,500 TV set-model numbers in single chronological order, providing quick identification of series of knobs required.—**TV Development Corp.**, 469 Jericho Turnpike, Mineola, N.Y.

MICROPHONE CATALOG No. 1000 gives type, response, output, application and price of each microphone in manufacturer's new 400 series. Adjustable impedance and response are also shown.—**Turner Microphone Co.**, 909 17th St. N.E., Cedar Rapids, Iowa.

BI-PHONIC COUPLER THIN SPEAKER SYSTEM is described in a two-color catalog sheet, with photographs and full specifications. —**Advanced Acoustics Co.**, 67 Factory Place, Cedar Grove, N.J.

SERVICE PRODUCTS are listed in new hanging wall *Catalog C-457*. Manufacturer's line of radio, hi-fi and TV capacitors are indexed for easy reference to ratings and types. 10c.—**Sprague Electric Co.**, North Adams, Mass.

ELECTRONIC PARTS AND EQUIPMENT are shown in a 444-page catalog of over 60,000 items, including manufacturer's line of electronic kits and components, and stereo hi-fi equipment of other leading makes. Other sections include PA systems, amateur radio equipment, tape recorders and TV components.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

ACOUSTIC SUSPENSION SPEAKERS are described in this 8-page illustrated catalog. General information and technical specifications included.—**Acoustic Research Inc.**, 24 Thorndike St., Cambridge 41, Mass.

STEREO HI-FI COMPONENTS of major manufacturers featured in 340-page *Catalog No. 620*. Also included are Citizens band equipment, radio and TV components and other items for hobbyists and experimenters.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N.Y.

PHONOGRAPH REFERENCE CHART lists complete line of manufacturer's cartridges—stereo-mono, ceramic and crystal, indicating which is used in every phonograph in use today. Also listed are 1,777 record player models, showing where Sonotone cartridges are used as original equipment and where they may be used as replacement.—**Sonotone Corp.**, Elmsford, N.Y.

CAPACITORS AND RESISTORS are shown in 56-page Industrial *Catalog IDC-561*. Sections include electrolytic, paper, MIL-type, metallized-paper, mica, ceramic and ac motor capacitors; plate assemblies, filters and resistors.—**Aerovox**, 740 Belleville, New Bedford, Mass.

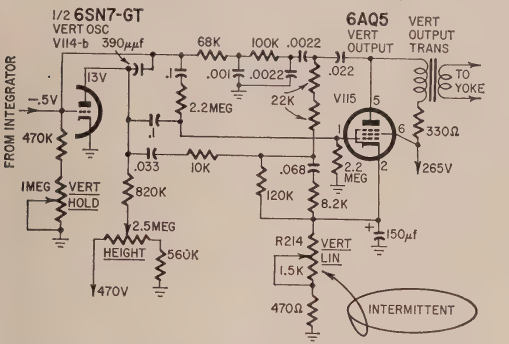
HI-FI COMPONENTS are described in 2 illustrated brochures. Complete specs given on all current items, both assembled and in kit form.—**Harman-Kardon**, Ames Court, Plainview, N.Y.

INDUSTRIAL ELECTRONICS *Catalog No. 72*. 496 pages of electronic parts, components and equipment—meters, transistors, test equipment, controls, capacitors, tools, hi-fi gear, etc. Most items illustrated, with brief description. —**Newark Electronics Corp.**, 223 W. Madison St., Chicago 6, Ill. END

Technotes

RCA 17T172K

The symptom was no vertical deflection. I removed the back of the set, thinking that a new output or oscillator tube would restore normal operation, but they didn't, and it was



off to the shop. Voltage checks on the oscillator showed −0.5 volt on the oscillator grid instead of a normal −14 volts and 13 volts on the plate instead of 53. Resistance measurements in grid and plate circuits showed nothing wrong. Continued trouble shooting took me into the vertical output stage and the vertical linearity control, R214, in the output tube cathode circuit. Replacing the control restored normal operation.—*Priestly Johnson*

CAM-ANGLE METER

The model 27-14 cam-angle meter manufactured by Allen Electric & Equipment Co. (Kalamazoo, Mich.) is used by garages to set distributor points. The unit contains a 1N48 diode which is subjected to the primary-circuit ignition pulses in its reverse direction. This diode is rated at 85 volts inverse, but ignition pulses can run up to 300 volts and the diode is frequently overvolted and may short out. If the diode is found shorted, replace it with something that has a higher inverse voltage rating, such as a Sarkes-Tarzian F-6 rectifier.

If the meter will not come up to the set point when the dry cell is a bit down, try reducing the size of the 390-ohm resistor. Its value does not affect accuracy, and a smaller value will allow the dry cell to be used longer. As long as the meter can be brought to the set point, the instrument will be accurate.—*Charles Erwin Cohn*

SIMPSON 260VOM

I recently loaned my meter to a hi-fi enthusiast who wished to check out some of his amplifier equipment. In his enthusiasm he misused the meter (he mentioned some vague difficulty when he returned it). I found that all three resistance ranges were dead. The trouble was an open resistor, R-16. I concluded that the user had attempted to use the meter as a voltmeter with the range switch in a resistance position.

To repair the meter, first order a new resistor from the manufacturer; it doesn't pay to wind one. Assuming you have a new resistor, your troubles have started. The resistors are set in cavities in a plastic block with both top and bottom leads feeding from the bottom of the cavity. If you are a good mechanic and have plenty of time, you can

"ONE DOLLAR" buys

As much as $15 worth – Everything Brand New and sold to you with a money back guarantee.

DEDUCT 10% ON ANY ORDER OF $10 OR OVER (ON THESE DOLLAR BUYS) Plus a FREE SURPRISE PACKAGE

- ☐ **1 – 5" PM SPEAKER** alnico #5 magnet $1
- ☐ **1 – 4" PM SPEAKER** alnico #5 magnet $1
- ☐ **1 – 3" PM SPEAKER** alnico #5 magnet $1
- ☐ **1 – 3½" TWEETER SPEAKER** for Hi-Fi $1
- ☐ **3 – AUDIO OUTPUT TRANSFORMERS** 50L6 type $1
- ☐ **2 – AUDIO OUTPUT TRANSFORMERS** 50L6 push-pull . . $1
- ☐ **3 – AUDIO OUTPUT TRANSFORMERS** 6K6 or 6V6 type . . $1
- ☐ **2 – AUDIO OUTPUT TRANSFORMERS** 6K6 push-pull . . . $1
- ☐ **3 – AUDIO OUTPUT TRANSFORMERS** 3Q4, 3Q5, 3S4 . . $1
- ☐ **10 – CHOKE TRANSFORMERS** 75 Ω, 1 henry, 100ma . $1
- ☐ **5 – SETS SPEAKERS PLUGS** wired, long leads $1
- ☐ **3 – I.F. COIL TRANSFORMERS** most popular 456kc $1
- ☐ **3 – I.F. COIL TRNSFRMRS** 456kc transistor type ¾x¾" . . $1
- ☐ **2 – G.E. #RTL 143 I.F. COIL TRNSFRMRS** 456kc w/flange . $1
- ☐ **3 – I.F. COIL TRANSFORMERS** 10.7mc for FM $1
- ☐ **3 – I.F. COIL TRANSFORMERS** 262kc for Auto Radios . . $1
- ☐ **100' – FINEST NYLON DIAL CORD** best size, .028 gauge . $1
- ☐ **4 – OVAL LOOP ANTENNAS** assorted popular sizes $1
- ☐ **3 – LOOPSTICK ANTENNAS** hi-gain, ferrite, adjustable . . . $1
- ☐ **3 – VARIABLE CONDENSERS** superhet 420/162 mfd . . $1
- ☐ **3 – ASST. SIZES RADIO CHASSIS PANS** drilled & plated $1
- ☐ **12 – RADIO OSCILLATOR COILS** standard 456kc $1
- ☐ **3 – ½ MEG VOLUME CONTROLS** with switch $1
- ☐ **5 – ½ MEG VOLUME CONTROLS** less switch $1
- ☐ **5 – 1 MEG VOLUME CONTROLS** less switch $1
- ☐ **5 – 50K VOLUME CONTROLS** less switch $1
- ☐ **4 – ASST. 5 WATT WIREWOUND CONTROLS** $1
- ☐ **10 – ASSORTED VOLUME CONTROLS** less switch $1
- ☐ **5 – ASSORTED VOLUME CONTROLS** with switch . . $1
- ☐ **100 – VOLUME CONTROL HEX NUTS** fits ⅜" bushing . . $1
- ☐ **10 – SURE-GRIP ALLIGATOR CLIPS** 2" plated $1
- ☐ **1 – GOLD GRILLE CLOTH** 14"x14" or 12"x18" $1
- ☐ **10 – SETS PHONO PLUGS & PIN-JACKS** RCA type $1
- ☐ **2 – $2.50 SAPPHIRE NEEDLES** good for 10,000 plays . . $1
- ☐ **20 – ASST. PILOT LIGHTS** #44, 46, 47, 51, etc. $1
- ☐ **10 – PILOT LIGHT SOCKETS** bayonet type, wired $1
- ☐ **50 – ASSORTED TERMINAL STRIPS** 1, 2, 3, 4 lugs . . . $1
- ☐ **35 – ASST. RADIO KNOBS** screw and push-on types $1
- ☐ **100 – ASSORTED KNOB SET-SCREWS** best sizes . . $1
- ☐ **25 – ASSORTED RADIO DIAL POINTERS** popular types . . $1
- ☐ **25 – ASSORTED CLOCK RADIO KNOBS** in colors . . $1
- ☐ **50 – ACORN RADIO KNOBS** ½" diameter, push-on $1
- ☐ **100 – ASSORTED ½ WATT RESISTORS** some in 5% tol. . $1
- ☐ **70 – ASSORTED 1 WATT RESISTORS** some in 5% tol. . $1
- ☐ **35 – ASSORTED 2 WATT RESISTORS** some in 5% tol. . $1
- ☐ **50 – ASSORTED FUSES** popular sizes 3AG, 4AG, etc. . . $1
- ☐ **50 – ASSORTED TUBULAR CONDENSERS** .001 to .47 . $1
- ☐ **20 – ASS'TED WIREWOUND RESISTORS** 5, 10, 20 watt . . $1
- ☐ **20 – WIREWOUND RESISTORS** 20 ohm, 10 watt $1
- ☐ **20 – WIREWOUND RESISTORS** 50 ohm, 10 watt $1
- ☐ **40 – ASST. PRECISION RESISTORS** in 1 percenters . . $1
- ☐ **35 – ASS'TED DISC CERAMICS** most popular numbers . . $1
- ☐ **35 – DISC CERAMICS** 5K mms $1
- ☐ **25 – ASSORTED MICA TRIMMER CONDENSERS** . . $1
- ☐ **15 – TUBULAR CONDENSERS** .047-600v $1
- ☐ **15 – TUBULAR CONDENSERS** .47-400v $1
- ☐ **20 – TUBULAR CONDENSERS** .01-600v $1
- ☐ **15 – TUBULAR CONDENSERS** .1-600v $1
- ☐ **15 – TUBULAR CONDENSERS** .25-600v $1
- ☐ **10 – HV CONDS.** .007-1600v $1
- ☐ **3 – ELECTROLYTIC CONDENSERS** 50/30-150v $1
- ☐ **2 – ELECTROLYTIC CONDENSERS** 80/80/20-150v . . $1
- ☐ **10 – ASST. RADIO ELECTROLYTIC CONDENSERS** . . $1
- ☐ **5 – ASST. TV ELECTROLYTIC CONDENSERS** $1
- ☐ **2 – ELECTROLYTIC CONDENSERS** 40/40-450v $1
- ☐ **3 – ELECTROLYTIC CONDENSERS** 16/16-450v $1
- ☐ **4 – ELECTROLYTIC CONDENSERS** 80-400v $1
- ☐ **30 – FP ELECTROLYTIC COND. MOUNTING WAFERS** $1
- ☐ **2 – ELECTROLYTIC CONDENSERS** 50/50-150v $1
- ☐ **5 – ELECTROLYTIC CONDENSERS** 25-50v $1
- ☐ **5 – ELECTROLYTIC CONDENSERS** 100-50v $1
- ☐ **50 – 100K ½ WATT RESISTORS** 10% $1
- ☐ **50 – 220K ½ WATT RESISTORS** 10% $1
- ☐ **50 – 470K ½ WATT RESISTORS** 10% $1
- ☐ **5 – DIODE CRYSTALS** 2-1N21 1-1N34, 1-1N60, 1-1N64 . . . . $1
- ☐ **4 – DIODE CRYSTALS** 1-1N34 1-1N60, 1-1N69, 1-1N82 . . . $1
- ☐ **3 – SELENIUM RECTIFIERS** 2 - 65ma and 1 - 75ma $1
- ☐ **2 – SELENIUM RECTIFIERS** 1 - 100ma and 1 - 25ma $1
- ☐ **2 – SELENIUM RECTIFIERS** 1 - 75ma and 1 - 350ma $1
- ☐ **2 – SELENIUM RECTIFIERS** 1 - 65ma and 1 - 450ma $1
- ☐ **100 – ASST. RUBBER FEET FOR CABINETS** in sets $1
- ☐ **20 – INSTRUMENT POINTER KNOBS** popular screw type $1
- ☐ **35 – ASSORTED SOCKETS** 7 pin, 8 pin, 9 pin $1
- ☐ **25 – ASSORTED PRINTED CIRCUIT SOCKETS** best types $1
- ☐ **30 – ASST. TUBE SHIELDS** for 7 pin and 9 pin Tubes $1
- ☐ **3 – ASST TOG SWITCHES** $1
- ☐ **15 – ASST. ROTARY SWITCHES** regular value $15 $1
- ☐ **1 – LB SPOOL ROSIN-CORE SOLDER** 40/60 . . . . $1
- ☐ **600 – ASST HARDWARE KIT** screws, nuts, washers, rivets, etc. $1
- ☐ **200 – ASST. SELF TAPPING SCREWS** #6, #8, etc. . . . $1
- ☐ **200 – 6/32 SCREWS AND 200 – 6/32 HEX NUTS** $1
- ☐ **8 – ASST. LUCITE CASES** hinged cover, handy for parts . . $1
- ☐ **10 – 6' ELECTRIC LINE CORDS** with plug $1
- ☐ **5 – TV CHEATER CORDS** with both plugs $1
- ☐ **4 – 50' SPOOLS HOOK-UP WIRE** 4 different colors . . . $1
- ☐ **25' – INSULATED SHIELDED WIRE** #20, braid, metal jackets $1
- ☐ **75' – MINIATURE ZIP CORD** 2 conductor, 101 uses $1
- ☐ **35' – TEST PROD WIRE** deluxe quality, red or black . . . $1
- ☐ **50 – STRIPS ASSORTED SPAGHETTI** handy sizes, lngths $1
- ☐ **100 – ASSORTED RUBBER GROMMETS** best sizes $1
- ☐ **50' – HI - VOLTAGE WIRE** $1
- ☐ **75' – BEST ZIP CORD #18** approved in brown or ivory . . . $1
- ☐ **200' – BUSS WIRE** #20, tinned $1
- ☐ **200' – HOOK - UP WIRE** any color of your choice $1
- ☐ **250 – ASST. SOLDERING LUGS** best types and sizes . . $1
- ☐ **300 – ASST. ½ WATT RESISTORS** short leads $1
- ☐ **50 – ASST. MOLDED CONDENSERS** short leads $1
- ☐ **50 – ASST. MICA CONDENSERS** some in 5% tol. . $1
- ☐ **50 – ASST. CERAMIC CONDENSERS** some in 5% tol. . . $1
- ☐ **35 – MICA CONDENSERS** 20 – 5mmf and 15 – 25mmf . . $1
- ☐ **35 – MICA CONDENSERS** 20 – 50mmf and 15 – 68mmf . $1
- ☐ **35 – MICA CONDENSERS** 20 – 100mmf and 15 – 250mmf $1
- ☐ **35 – MICA CONDENSERS** 20 – 470mmf and 15 – 680mmf $1
- ☐ **35 – MICA CONDENSERS** 20 – 820mmf & 15 – 1000mmf $1
- ☐ **35 – MICA CONDENSERS** 20 – 2200mmf & 15 – 2400mmf $1
- ☐ **35 – MICA CONDENSERS** 20 – 3300mmf & 15 – 4700mmf $1
- ☐ **35 – MICA CONDENSERS** 20 – 6800mmf, 15 – 10000mmf $1
- ☐ **35 – CERAMIC CONDENSERS** 20–5mmf and 15–10mmf . $1
- ☐ **35 – CERAMIC CONDENSERS** 20–25mmf and 15–47mmf $1
- ☐ **35 – CERAMIC CONDENSERS** 20–56mmf and 15–82mmf $1
- ☐ **35 – CERAMIC CONDENSERS** 20–100mmf & 15–150mmf $1
- ☐ **35 – CERAMIC CONDENSERS** 20–250mmf & 15–470mmf $1
- ☐ **35 – CERAMIC CONDENSERS** 20-1000mmf & 15-1500mmf $1
- ☐ **35 – CERAMIC CONDENSERS** 20-2000mmf & 15-5000mmf $1
- ☐ **10 – SYLVANIA 1AB5 TUBES** $1
- ☐ **10 – ASSORTED RADIO & TV TUBES** $1
- ☐ **4 – TUNGSOL 1U4 TUBES** also serves as a 1T4 . . . . . . $1
- ☐ **3 – GENERAL ELECTRIC 35W4 TUBES** $1
- ☐ **STANDARD BRAND TUBES** 0Z4, 1B3, 1X2, 5U4, 5Y3, 6AC7, 6AU6, 6AX4, 6CB6, 6CG7, 6J6, 6K6, 6SN7, 6U8, 6X8, 12AT7, 12AU7, 12AX4, 50L6. . . . . . . Each $1
- ☐ **$15.00 TELEVISION PARTS "JACKPOT"** best buy ever . $1
- ☐ **1 – $10 INDOOR TV ANTENNA** hi-gain, 3 section, tiltproof $1
- ☐ **100' — TWIN TV LEAD-IN WIRE** 300 ohm, heavy duty . $1
- ☐ **50' – FLAT 4-CONDUCTOR WIRE** many purposes $1
- ☐ **20 – ASSORTED TV KNOBS ESCUTCHEONS,** $20 value . $1
- ☐ **15 – ASSORTED STANDARD TUNER VHF STRIPS** $1
- ☐ **6 – ASSORTED STANDARD TUNER UHF STRIPS** $1
- ☐ **1 – 70° FLYBACK TRANSFORMER** incl Schematic Diagram $1
- ☐ **1 – 90° FLYBACK TRANSFORMER** incl Schematic Diagram $1
- ☐ **3 – $11 TODD 60° DEFLECTION YOKES** $1
- ☐ **25 – ASSORTED TV PEAKING COILS** all popular types $1
- ☐ **2 – RATIO DETECTOR COILS** 4.5mc or 10.7mc . . $1
- ☐ **2 – TV SOUND I. F. COILS** 4.5mc or 21.25mc $1
- ☐ **2 – RCA SYNCHROGUIDE COILS** #205R1 . . . . $1
- ☐ **2 – SOUND DISCRIMINATOR COILS** 4.5mc $1
- ☐ **2 – SOUND DISCRIMINATOR COILS** 10.7mc $1
- ☐ **1 – TV VERTICAL OUTPUT TRANSFORMER** 10 to 1 ratio $1
- ☐ **1 – TV VERTICAL OUTPUT TRANSFORMER** 16 to 1 ratio $1
- ☐ **1 – VERTICAL BLOCKING TRANSFORMER** standard type $1
- ☐ **4 – TV ION TRAPS** —all TV's $1
- ☐ **4 – TV CENTERING RINGS** fits on back of deflection yoke . . $1
- ☐ **15 – ASSORTED TV COILS** sync, peaking, width, ratio, etc $1
- ☐ **5 – TV CRT SOCKETS** 20" leads $1
- ☐ **5 – TV HI-VOLT ANODE LEADS** complete with 20" lead $1
- ☐ **3 – TV CARTWHEEL CONDENSERS** 20kv $1
- ☐ **2 – TV CARTWHEEL CONDENSERS** 30kv $1
- ☐ **3 – HV RECTIFIER SOCKETS** for 1B3 Tube, mounted . $1
- ☐ **3 – HV RECTIFIER SOCKETS** for 1X2 Tube, mounted . $1
- ☐ **1 – TV FOCALIZER** adjustable for any ohmage . . . $1
- ☐ **1 – SILICON RECTIFIER** 750ma, 500PIV $1
- ☐ **2 – SILICON RECTIFIERS** 500ma, 400PIV $1
- ☐ **3 – SILICON RECTIFIERS** 350ma, 200PIV $1
- ☐ **15 – ASST HANDY RADIO & TV BRACKETS** many uses $1
- ☐ **3 – TV ALIGNMENT TOOLS** Assortment #1 . . . . $1
- ☐ **3 – TV ALIGNMENT TOOLS** Assortment #2 . . . . $1
- ☐ **3 – TV ALIGNMENT TOOLS** Assortment #3 . . . . $1
- ☐ **3 – TV ALIGNMENT TOOLS** Assortment #4 . . . . $1
- ☐ **3 – TV ALIGNMENT TOOLS** Assortment #5 . . . . $1
- ☐ **3 – ASST SLIDE SWITCHES** $1
- ☐ **3 – ROTARY SWITCHES** 3 position dpdt. $1

(EACH ALIGNMENT TOOL is different & valued at over $1)

HANDY WAY TO ORDER — Simply pencil mark items wanted (X in square is sufficient), enclose with money order or check. You will receive a new copy of these offers for re-orders.

ON SMALL ORDERS — Include stamps for postage, excess refunded. LARGER ORDERS shipped express charges collect.

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359

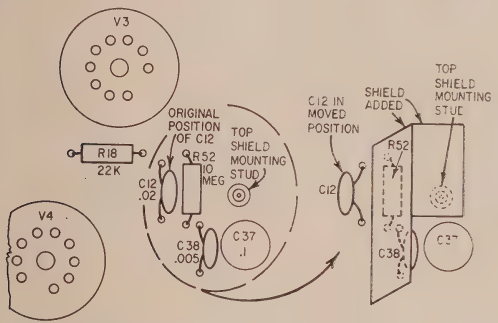
loosen the resistor board and wiring, pull the board and replace the resistor. However, there is an easier way:

1. Cut the top lead to the old R16 next to the resistor.
2. Twist off the bottom lead next to the resistor by holding it from the back of the panel with long-nose pliers and carefully twisting R16 back and forth with another pair of long-nose pliers at the top of resistor.
3. Fish the lead which went to the bottom of R16 out of the cavity and as far to the right (looking at rear of meter) as possible.
4. Solder one side of the new R16 to the wire which went to the top of the old resistor, leaving about 1 inch of lead on it.
5. Lay the new R16 in the upper part of the outer circular groove which is under the cover plate that goes over R23 and R24.
6. Connect the other side of the new R16 to the lead which was fished from the bottom of the cavity, by going around the right side of the molded plate. (Cover the resistor lead with spaghetti.)
7. File the cover plate so that it will seat around the resistor. This is important because the meter fits into the case with very little clearance.—*Art Bennett*

ALLIED 83 YX 774

To prevent the right-channel signal from coupling to the left channel, especially at low volume, install an additional shield as shown.

The circuit diagram of the set reveals that R52, C38, C37 belong to the right-channel rumble filter and C12 is the left-channel coupling capacitor. Thus the right channel signal couples through this capacitor to the left channel.



Installing the additional shield around these parts, mounted on the same stud where the original top shield plate is anchored, eliminated the coupling.—*Themistocles Q. Sarmiento*

RCA 17-S-6022

Some of these sets develop a buzz which is heard at all settings of the volume control. Sometimes the buzz is caused by the lead which connects resistor R109 to the 200,000-ohm tape on the volume control touching the control's case. Slip a piece of spaghetti over the lead, wrap a piece of tape around it or simply dress the lead away from the control to cure this trouble—*Warren Roy*

END

WE BUY TECHNOTES

RADIO-ELECTRONICS wants Industrial Technotes. These should cover equipment (including closed-circuit television) actually used in industrial work, or technotes on counters, controls and other apparatus whose users are largely industrial. Unillustrated Technotes pay $5; circuit diagrams raise the price to $9 and acceptable photos are worth $7 each. Send your technotes from industry to Technotes Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y.

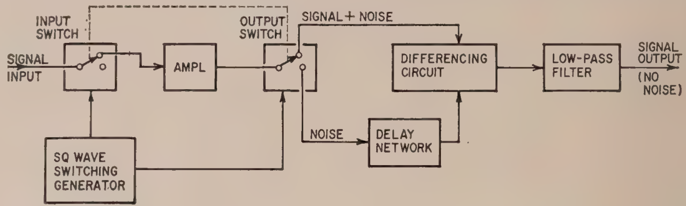
new PATENTS

NOISELESS CIRCUIT

Patent No. 2,970,276

Kenneth Dollinger, Derry, N. H. (Assigned to Ratheon Co.)

The input and output switches are synced by the square wave. In the position shown, the signal plus noise generated in the amplifier passes into a differencing or subtractive circuit. In the other position, noise only is passed to the differencing circuit. The noise is delayed slightly so that both (noise plus signal) and (noise alone) arrive simultaneously. Since the differencing circuit subtracts one voltage from the other, when the two noise signals arrive, they cancel and are eliminated.



The low-pass filter eliminates the square wave, whose frequency is much higher than that of the signal.

DIGITAL TO ANALOG CONVERTER

Patent No. 2,970,308

George S. Stringfellow and Erwin J. Emkjer, San Diego, Calif. (Assigned to General Dynamics Corp., San Diego)

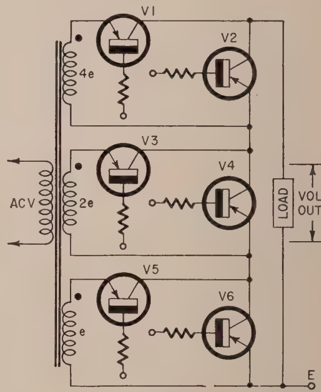
In binary arithmetic, only powers of 2 are used: 1, 2, 4, 8. . . . This device receives binary information corresponding to a given number, and delivers a voltage equal to the sum. Each of the binary stages is labeled e, 2e, 4e and so on. Only three stages are shown.

Binary information from a computer or tape machine is fed in, each digit going simultaneously to the corresponding stage. For example, if the number is 5, stages e and 4e will be energized, stage 2e remaining off. Each energized stage delivers a voltage from its transformer secondary, which is specially wound to generate the proper voltage. All secondaries are similarly poled.

Each stage contains a pair of switching transistors, such as V1, V2. Normally, odd-numbered transistors are blocked by a positive base voltage. Also, even-numbered transistors conduct due to a negative base voltage. E, a reference voltage, is at ground potential.

To energize a stage, bias voltages at the transistor bases are reversed. Therefore the odd-numbered transistor of such a stage is driven to conduction and delivers the required voltage from its transformer coil. At this time the even-numbered transistor becomes an open switch.

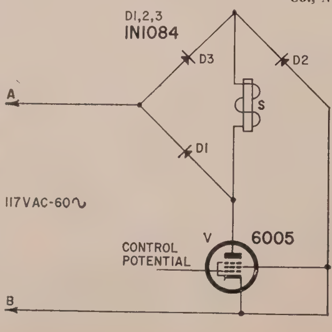
In each stage, one transistor is conducting at any time. Thus the same dc voltage, E, is at all emitters and collectors. The transistors are activated by ac from the transformer.



CONTROL CIRCUIT

Patent No. 2,970,247

Frank W. Hill, Moline, Ill. (Assigned to Gamewell Co., Newton, Mass.)



A weak signal to tube V controls heavy current through the solenoid. The diodes are silicon types 1N1084 rated at 500 ma. The tube is a 6005.

The ac line is represented by A, B. When A goes negative, load current flows through D1, the solenoid and D2. If the grid signal is negative, V blocks during the other half-cycle. With only half-wave power supplied to it the solenoid is not fully energized.

When the grid goes positive, V conducts when A goes positive. The path is through D3, the solenoid and V. Only under this condition full-wave power flows through the solenoid to energize it fully.

END

TECHNICIANS' NEWS

THE WOMEN COMPLAIN

New York—Of all complaints made against service technicians by women, two-thirds are attributed to lack of interest and discourtesy, according to Miss Willie Mae Rogers, director of the Good Housekeeping Institute. This statement was made at an Electronic Industries Association conference and reported by *Home Furnishings Daily.*

Miss Rogers gave six main items as the leading complaints: inefficient service; delay in getting a technician to call; unavailability of parts; the "attitude" of the service technician; cost, and broken appointments.

To eliminate these problems, five things that every technician should be taught were suggested—knowledge of the product and how to repair it; neatness; courtesy, responsibility for leaving a house as it was found, and confidence in the product.

CAPTIVE SERVICE—1988

The following item is pure fiction. It is one man's view of what captive service and extended warrantees may turn into. It is an item important to every service technician.

THE CAPTOR SPEAKS

By T. F. SINCLAIR

MEMO
To: All Little Wonder Sales and Service Dealers
From: J. R. Hamilton, Vice President, Little Wonder Service Co.

GENTLEMEN:

In light of some recent findings furnished this office by the Garies Security Agency, it appears that our captive service policy is in need of additional safeguards. The Garies Agency reports that even though all service literature and schematics for our *Little Wonder* television receiver are distributed only to authorized sales–service shops some of this material is falling into the hands of outsiders (independents). It is further rumored that persons unknown are surreptitiously supplying an underground network of independents with the recent circuit modifications that we have been employing as a confusion tactic. The immensity of this problem is evident. We may be deprived of our advantage over the independent and be forced to compete with him on a "may the best shop win" basis. This must never be!

To regain our tenable position in the servicing field I have presented a list of suggested model changes and service procedures to the *Little Wonder* front office. The proposals are outlined below:

1. All *Little Wonder* television receivers shall be provided with a tamperproof cabinet. Access to the electronic circuitry will be provided by a locked rear panel. Authorized *Little Wonder* service dealers will be provided with one key and, to safeguard its use will be required to post a $500 bond. If this key is lost or is missing from a

Little Wonder service shop at any time, forfeiture of the bond will result.

2. In the event that an extremely zealous independent should force the access door, a concealed microswitch will activate a booby-trap circuit. Upon contact with the switch, a high-voltage capacitor will discharge *inside* the picture tube and, activated by an auxiliary grid network, the resultant electron beam will cause the inscription **GUARANTEE VOID** to be permanently burned into the phosphor face of the tube. Not only will this cause the independent considerable embarrassment, but he will also have to make good for a new picture tube.

3. Finally, all requests for replacement components must be accompanied by the secret seal of *Little Wonder* service organizations. Orders received without this seal will be subject to suspicion and replacements will be shipped to such customers by way of Bora-Bora aboard the H.M.S. Boondock.

It is hoped, that when adopted, these stern measures will again place the servicing of *Little Wonder* television receivers where it belongs: in the shops of *Little Wonder* dealers. Until then, remember our creed: CAPTIVE SERVICE MEANS A CAPTIVE BUCK.

ACTION IN WISCONSIN

Sheboygan County—Newspaper advertising was discussed at a recent meeting of the TESA affiliate for this area. The group decided to continue running a weekly ad.

An interesting cooperative approach to odd-ball parts was suggested. All members would compile a list of such parts on their shelves. Every shop has a supply of parts that were popular at one time but are gathering dust today. From time to time every shop needs a part for one of those older sets that is difficult or impossible to get. With a composite list of the stock of every association technician, one member could get a needed part from another.

Jefferson and Dodge County—A membership drive led off the fall meeting. All service technicians in the area were invited to attend a meeting at Otto's Inn in Watertown.

Milwaukee—As usual, Covic's Amerwood hall was the meeting site. Tom Bailey of the Electric Co. gave an informative and humorous talk, illustrated with color slides, on interference sources and problems encountered by his department in their work as interference troubleshooters.

YOU GOTTA GET PAID

San Diego, Calif.—A query from a California State Electronics Association member asked about the sale of property that has had a lien placed on it for service work. The following is the answer given by the association's legal adviser. While this may not be exactly the same in all states some similar provision is usually applicable.

"A person who makes, alters or repairs any article of personal property, at the request of the owner, or legal possessor of the property, has a lien on the property for his reasonable charges for the balance due for such work done and materials furnished, and may retain possession of the same until the charges are paid.

"If the person entitled to the lien is not paid the amount due within 10 days after it has become due, the lien holder may sell the property, or as much as may be necessary to satisfy the lien and costs of sale at public auction. He must give at least 10 but not more than 20 days previous notice of such sale by advertising in some newspaper published in the county in which the property is situated.

"The public notice must be published in a newspaper of general circulation to the public, not a trade publication, and a complete description of the article must be included in the notice. The lien holder may bid on the article but any money over the amount of the lien, plus costs, must be returned to the owner.

"The portion of any lien in excess of $200.00 for any work performed at the request of *any person other than the holder of the legal title*, shall be invalid, unless prior to commencing any such work, the person claiming such lien shall give actual notice thereof in writing either by personal service or by registered letter addressed to the holder of the legal title to such property, if known."—*Modern Electronic Service Dealer*

RADIO FIX-UP DRIVE UNDERWAY

Harrisburg, Pa.—A state-wide "fix your radio" program is being pushed by the Federation of Television & Radio Service Associations. The campaign is aimed at putting all unused radios in the customer's home into working order. Under the plan, conducted with the cooperation of the State Civil Defense Department, set owners are being urged to have their radios put into operating order and their radio dials marked for the Conelrad frequencies.

TECHS READY FOR COLOR

Chicago, Ill.—Ralph Woertendyke, new NATESA president, stated at the national convention that the independent television service technician is prepared, now, to service color TV. He went on to say that these same technicians are also ready to handle FM receiver service. Mr. Woertendyke explained that many of the major color TV manufacturers have made available to the independent technician the necessary information to enable him to do the servicing.

TECHNICIAN TRAINING

Louisiana—A completely new series of courses has been added to the State Radio & Television Technicians Board's list of available training for licensed technicians under its extension training program. Classes in color TV and transistor service have been added to the already established monochrome courses. The interest of technicians in acquiring more knowledge of circuitry and service is evidenced by the large response to the courses, which are held in each area of the state. In some cases, the number of classes doubled and quadrupled.—*TESA–St. Louis News* END

new BOOKS

TRANSFORMERS, edited by Alexander Schure. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N.Y. 5½x8½ in. 82 pp. $2.

Begins with magnetic theory and covers iron-core and air-core types. Simple math and examples show applications in amplifiers, power supplies and control devices.

RAPID AUTO RADIO REPAIR, by G. Warren Heath. Howard W. Sams & Co., Inc., 1726 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 158 pp. $2.95.

All types of auto sets are discussed: FM, foreign, hybrid, printed-circuit. Text and diagrams are keyed for speed in servicing.

SOLAR CELL AND PHOTOCELL HANDBOOK. International Rectifier Corp., El Segundo, Calif. 6 x 9 in. 112 pp. $2.

This book describes the cells and tells how to use them. Contains elementary radiation theory, and describes over 75 practical, easy-to-build projects.

TV RECEIVER SERVICING, (Vol. 1), by E. A. W. Spreadbury. Iliffe Books, Ltd., Dorset House, Stamford St., London, S.E. 1, England. 5½ x 8½ in. 364 pp. 25 shillings.

Author includes unusual problems and topics: spot wobble, picture expanders, protection against implosion, X-rays, etc.

INTERNATIONAL DICTIONARY OF PHYSICS AND ELECTRONICS (2nd Edition). Edited by Walter C. Michels, Rosalie C. Hoyt and Joseph C. May. D. Van Nostrand Co., Inc., Princeton, N.J. 7½ x 10½ inches. 1355 pages. $27.85.

New edition is 350 pages larger than the first, printed in 1956, covering a large number of terms added by the advance of science.

STEREOPHONIC SOUND (2nd Edition), by Norman H. Crowhurst. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N.Y. 5½x8½ in. 136 pp. $2.90.

Plain language, diagrams and photos combine to tell the story of stereo for the home listener. Covers FM, disc, tape.

CROSSED-FIELD MICROWAVE DEVICES. Edited by E. Okress. Academic Press, 111 Fifth Ave., New York 3, N.Y. 6 x 9 in., Vol. 1. 648 pp. $22. Vol. 2. 520 pp. $18.

Many physicists have contributed to these volumes, analyzing the devices, working out basic theory and discussing the problems. Vol. 1 deals with the principal elements. Vol. 2 covers types, analysis and developments in US, France and Japan.

THE STORY OF ATOMIC ENERGY, by Laura Fermi. Random House. 475 Madison Ave., New York, N.Y. 6 x 8½ in. 178 pp. $1.95.

Mrs. Fermi, widow of the renowned physicist, has written an absorbing

SCHOOL DIRECTORY

book, beginning with Democritus and showing how the work of each succeeding hero in our struggle to understand the atom has contributed to our present knowledge and use of atomic energy. Aimed at young readers.

SEMICONDUCTORS, edited by N. B. Hannay. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. 6 x 9 in. 767 pp. $15.

Comprehensive reference on chemical and physical aspects of semiconductors.

CYBERNETICS WITHOUT MATHEMATICS by Henry Greniewski. Pergamon Press, 122 E. 55th St., New York 22, N.Y. 5½ x 8½ in. 201 pp. $6.

A brief, nonmathematical introduction to cybernetics. END

CORRECTION

There is a discrepancy between the schematic and transmitter printed-circuit board in the four-channel radio-control system on page 32 of the November issue. The schematic shows pins 1 and 7 of V1, V3 and V4 going to ground (A− and B−) while on the circuit board they connect to A+. The change is made automatically if you use the board in Fig. 4. If you use ordinary point-to-point wiring on the transmitter, connect the filament center taps of all tubes, including V2, to A− and connect pins 1 and 7 of all tubes to A+.

We thank Mr. Marvin Livingston, of Stillwater, Okla., for bringing this to our attention.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF RADIO-ELECTRONICS published monthly at Mount Morris, Ill., for Oct. 1, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Hugo Gernsback, 154 W. 14 St., New York 11, N. Y.; Editor, M. Harvey Gernsback, 154 W. 14 St., New York 11, N. Y.; Managing editor, Fred Shunaman, 154 W. 14 St., New York 11, N. Y.; Business manager, (none).

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Gernsback Publications Inc., 154 W. 14 St., New York 11, N. Y.; Hugo Gernsback, 154 W. 14 St., New York 11, N. Y.; M. Harvey Gernsback, 154 W. 14 St., New York 11, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (It there are none, so state.) None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 157,516.

M. Harvey Gernsback

Sworn to and subscribed before me this 13th day of October, 1961.
[SEAL] Joane Dodge, Notary Public
(My commission expires March 30, 1962)

R-E Classified ADS

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 125

Niles Bryant School
Electronic Technical Institute
Indiana Technical College
International Correspondence School
Middleton Institute of Electronics
Milwaukee School of Engineering
Northrop Institute of Technology
Pacific International College of Arts & Sciences
Phila. Wireless Technical Institute
Philco Technological Center
Tri-State College
Valparaiso Technical Institute

Printed in USA

Rates—50¢ per word (including name, address and initials. Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for February issue must reach us before Nov. 11, 1961.
RADIO-ELECTRONICS, 154 West 14 St., New York 11, N. Y.

POPULAR Piano and Organ lessons on tape, $6.00, either tape. Write for particulars. **BOB MILLER TAPES,** Box 132-R, Cranford, N.J.

PROMPT DELIVERY. We will not be undersold. Amplifiers, Tape Recorders, Tuners, etc. No catalogs. Air Mail Quotes. Compare. **L. M. BROWN SALES CORP.** Dept. R, 239 E. 24th St., New York 10, N. Y.

APPLIANCE LAMP, range, vacuum parts wholesale. Illustrated catalog 25¢. **SECO,** 112 So. 20th St., Birmingham 3, Ala.

PROFESSIONAL ELECTRONIC PROJECTS—Organs, Timers, Computers, etc.—$1 each. List free. **PARKS,** Box 1665, Lake City, Seattle 55, Wash.

INVESTIGATORS, write for free brochure on latest subminiature electronic listening devices. **ACE ELECTRONICS,** Dept. 2C, 11500 NW 7th Ave., Miami 50, Fla.

NEW CONCEPT OF LEARNING SELF-HYPNOSIS! Now on tape or record! Free Literature. **McKINLEY-SMITH CO.,** Dept. T5, Box 3038, San Bernardino, Calif.

INCREASE your business. Free samples. **SCHOLLER PRINTERS,** 1747 Selby, St. Paul 4, Minn.

SAVE 30%. Stereophonic music on tape. Request tape, recorder Catalog R-1. **SAXITONE TAPE SALES,** 1776 Columbia Rd, Washington 9, D.C.

BEFORE YOU BUY Receiving Tubes or Hi-Fi Components send now for your giant FREE Zalytron current catalog—featuring nationally known Zalytron First Quality TV-Radio Tubes, Hi-Fi Stereo Systems, Kits, Parts, etc. All priced to Save You Plenty—Why Pay More? **ZALYTRON TUBE CORP.,** 220 W. 42nd St., N.Y.C.

100 FOREIGN STAMPS only 10¢ with approvals. **RORRY STAMPS,** 7521 Mason, Dept. 112, Canoga Park, Calif.

STEREO playback tape deck. Professional-quality precision-made Telefunken heads. Dual speed. SPECIAL price, $59.95. Send for details. **UNIVERSAL DIST CO.,** PO Box 204, Richmond Hill, N.Y.

RENT STEREO TAPES—over 2,000 different—all major labels—free catalog. **STEREO-PARTI,** 811-RE, Centinela Ave., Inglewood 3, Calif.

BUSINESS CARDS, LABELS, RUBBER STAMPS. Send for free descriptive literature. **HEIGHTS INDUSTRIES,** Capitol Heights 27, Md.

INVENTIONS WANTED for immediate promotion! Patented, unpatented. Outright cash; royalties; **CASCO,** Dept. 3, Mills Bldg., Washington 6, D.C.

CONVERT ANY TELEVISION to sensitive big-screen oscilloscope. Only minor changes necessary. Plans $1.95. **RELCO,** Box 10563-D, Houston 8, Tex.

BATTERY RECORDER, complete with case, microphone, tape, speaker. Guaranteed. $19.60 postpaid. **EASTMANS,** Box 7, Cedarhurst, N.Y.

RADIO AND TV TUBES. Jobber-boxed. RCA, G-E, Sylvania, Westinghouse—65% off list price. Brand-new, no government surplus, no manufacturers' rejects. 25% deposit on all orders; balance COD. FOB N.Y. **SUTTON ELECTRONICS,** Box 503 Hicksville, N.Y.

6 TRANSISTOR RADIO, complete, guaranteed, $13.50. **ZELECH,** 226 Shrewsbury, Redbank, N.J.

DIAGRAMS for TV, $2.00; radio, $1.00. **HIETT DIAGRAMS,** Box 865, Laredo, Tex.

ROTARY SWITCHES. Average government cost $33.00. Four types. Complete lot of 900 35¢ each, or $2.00 each individually. **CONTRACTORS SURPLUS CO.,** Williamstown, Mass.

TRANSISTORIZED test equipment. Perfect Christmas gifts. Popular-price range. **PEL ELECTRONICS,** Box 555C, Ridgewood, N.J.

BUY/RENT COMEDY, PARTY RECORDS. Sampler and catalogs, $1.00. **DRC,** 11024 Magnolia Blvd., No. Hollywood, Calif.

100 DIFFERENT United States commemorative stamps. ½¢ to 10¢ face, used $1.00; mint, $4.95. **IRWIN,** Box 12D, Brooklyn 29, N.Y.

RUBBER STAMPS. Three lines, $1.00. Labels, cards, etc. Free catalog. **ALCO,** Box 244-R, Urbana, Ill.

PRINTING PRESSES, type, supplies. List 4¢. **TURNBAUGH SERVICE,** Mechanicsburg, Pa.

RADIO & TV TUBES at Manufacturers' Prices! 100% Guaranteed! Brand-new! No rebrands or pulls! **UNITED RADIO,** Box 1000-R, Newark, N.J.

PIANO technique simplified. $1.25. **WALTER KAZAKS,** 234 E. 58 St., New York 22, N.Y.

PRINTING. Letterheads, envelopes, statements, billheads—the works, $9.95 postpaid. (Samples). **OKAYPRINT,** Martins Ferry 7, Ohio.

MULTIPLEX ADAPTER: circuit board, 5 coils, sockets and complete instructions, $15.00. **STONER,** Box 7388-W, Alta Loma, Calif.

PRECISION RESISTORS, carbon-deposit. Guaranteed 1% accuracy. Millions in stock. ½-watt, 8¢. 1-watt, 12¢. 2-watt, 15¢. Leading manufacturers. **ROCK DISTRIBUTING CO.,** 902 Corwin Rd., Rochester 10, N.Y.

SPEAK, SING with power. Self-training records. Thrilling! $9.95. **CANFIELD** 2018-K Fifth Ave. So., Minneapolis 4, Minn.

RADIOS, taperecorders, teleceivers, teleamplifiers. Everything Japanese. **UNITA,** 545 Fifth Ave., New York 17, N.Y.

COSMIC VOICE Educational Electronics Kits. One-time introductory offer to readers of Radio-Electronics. Hi-fi Diode Radio Kit complete, $1.25 postpaid. Send check or money order to **COSMIC VOICE INC.,** 909 W. Michigan Ave., Jackson, Mich.

ELECTRONIC SURPLUS CATALOG, 5,000 items. Send 10¢. **BILL SLEP CO.,** Drawer 178R, Ellenton, Fla.

DIAGRAMS FOR REPAIRING RADIOS, $1; television $2. Give make and model. **DIAGRAM SERVICE,** Box 672 RE, Hartford 1, Conn.

HI-FI AMPLIFIERS, tuners, speakers, Walkie Talkies, radios, telescopes, microscopes, cameras. LOW Prices. Free Catalog. **GM PHOTOELECTRONICS,** 623 Gay, Knoxville, Tenn.

JEEPS—$223.83. Transmitters—$6.18. Receivers—$5.65. Voltmeters—$1.05. Typewriters—$6.24. Multimeters, oscilloscopes, Walkie-Talkies, televisions, autos. Typical government surplus prices. Buy DIRECT. List of depots, procedure, inspection details, only $1.00. **N. Y. ENTERPRISES,** International Airport, Box 402-F11, Jamaica 30, N.Y.

Universal Replacement Parts Kit

MODEL 31T 3890

Popular Standard Coil field replacement parts used extensively by servicemen for STANDARD tuners manufactured from 1947-1956.

MODEL 31T 3890 A kit of mechanical and electrical parts for shop and field use to be used in conjunction with Section II of the STANDARD Cross Reference Guide. These parts make up 90% of the replacement parts most commonly used in field service.

INCLUDED FREE

- Special IF alignment tool for late model STANDARD TV and FM tuners.
- Popular special springs, detent springs and roller assembly, detent ball assemblies, etc.

BE PREPARED . . . GET YOURS TODAY from any authorized *Standard* COIL distributor

• **$27.99 DEALER NET**

standard kollsman INDUSTRIES INC.

FORMERLY STANDARD COIL PRODUCTS CO., INC., MELROSE PARK, ILLINOIS

SELL THE POPULAR RCA SILVERAMA PICTURE TUBE

To Increase Your Business and Build Customer Confidence

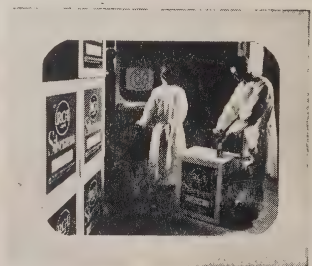
Before any RCA Silverama Picture Tube goes into its carton for shipment to your distributor, it has been through one of the most exhaustive series of quality tests in the picture-tube industry.

Every Silverama undergoes the same electrical tests as RCA's original equipment picture tubes. Even the Silverama envelope has been thoroughly cleaned, tested and inspected before re-use. Only then is the famous RCA high-quality phosphor screen added.

Such tests—plus uncompromising quality control at every step of manufacture, assure you that RCA Silverama is the finest replac ment TV-picture tube modern science and technology can produc

But most important to your business: this superior tube is price to compete with other name brand picture tubes. Thus for no extr cost you can provide the business-building extras of assured qua ity performance, fewer complaints, callbacks and in-warranty fai ures—plus the brand-name your customers want and trust, RC Silverama. See your authorized RCA Tube distributor today!

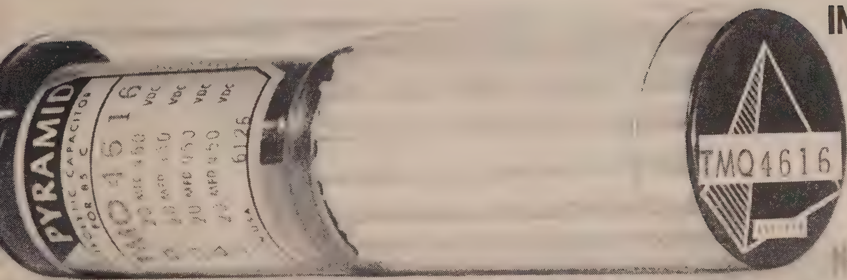
Automatic testing. 26 different tests for major characteristics are performed on this automatic test unit. A tube failing a single test is automatically rejected.



Final checkout. At the er of the production line, ju prior to packaging, samp batches of Silverama pi ture tubes receive a focu check for additional assu ance of quality.

RCA ELECTRON TUBE DIVISION, HARRISON, N. J.

The Most Trusted Name in Television


PYRAMID
TMQ4616

1961 ANNUAL INDEX

Vol. XXXI, January-December, 1961 RADIO-ELECTRONICS

KEY TO SYMBOLS AND ABBREVIATIONS

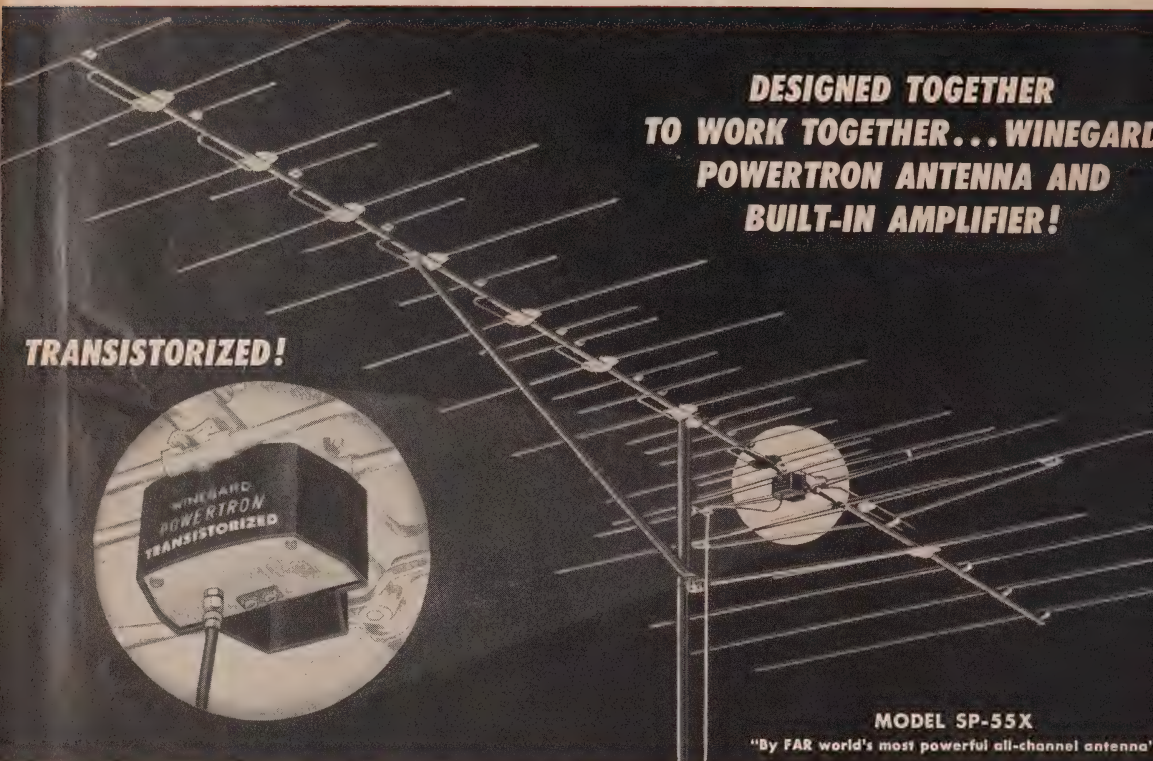
* Construction Articles
† Section of full-length article

Cl	Television Clinic
Corr	Correction
Corres	Correspondence
NB	News Briefs
NC	Noteworthy Circuits
Pat	New Patents
Tech	Technotes
TTO	Try This One
WN	What's New

Regular departments not itemized are Business and People, New Books, New Literature, New Products, Technicians' News.

(Continued on page 86)

Why the WINEGARD ELECTRONIC MOST EFFECTIVE TV ANTENNA...



WHY? BECAUSE...

IT CAPTURES MORE SIGNAL than any other all-channel antenna ever made. Patented design, electro-lens director system, dual "TAPERED T" driven elements, 30 precision-tuned elements in all.

IT'S THE ONLY TRUE ELECTRONIC ANTENNA. Only the Winegard Powertron is built with the amplifier as part of the driven element—not an "add-on" attachment.

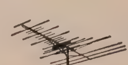
IT ELIMINATES ALL SIGNAL LOSS that normally occurs between the driven element and the amplifier due to transmission and coupling mis-match.

IT BOOSTS WEAK SIGNALS UP OUT OF THE SNOW far better than any other antenna or antenna-amplifier combination made.

FOR VIVID COLOR, HIGH DEFINITION BLACK AND WHITE AND LONG DISTANCE RECEPTION, nothing can compare to the Super Powertron. Thousands have been installed all over the country and our files are full of testimonials from grateful TV viewers and Service-Technicians alike.

WINEGARD IS THE ONLY MANUFACTURER THAT MAKES BOTH ANTENNAS AND RF AMPLIFIERS. Because of this you can feel confident of getting the very best. But don't take our word for it—let your eyes and ears and field strength meter tell the story.

MODEL P-55
Powertron — transistorized, 14 elements.



MODEL P-55X
Powertron with Pack — Transistorized, 21 elements.

MODEL SP-55X
Super Powertron — transistorized, 30 elements.

POWERTRON is by far WORLD'S

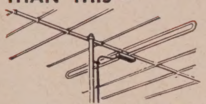
Not 60%...Not 70%...but over 95% efficient

OUTFEATURES—OUTPERFORMS ORDINARY ANTENNAS WITH "ADD-ON" TYPE SIGNAL BOOSTERS!

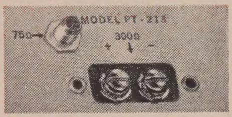
THIS IS BETTER—

Exclusive amplified "Tapered T" driven element for perfect match and lowest possible signal-to-noise ratio. Only Powertron has it.

THAN THIS—



Not an after-thought "add on" signal booster hung on an ordinary antenna — not an old fashioned mast mounted booster.

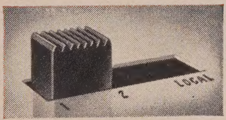


ONLY POWERTRON HAS *BOTH* 300 OHM TWIN LEAD OR 75 OHM COAX TERMINALS ON BUILT-IN AMPLIFIER.

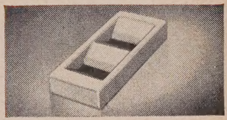
ONLY POWERTRON GIVES YOU YOUR CHOICE OF TRANSISTORS OR TUBES (TUBE MODELS 300 OHM ONLY).

POWERTRON HAS COMPLETELY AC POWER SUPPLY

Transistorized Model has rectifier and filter in power supply — not in amplifier, where servicing is difficult. No batteries. Costs 27c to operate for full year. Battery types require $5 to $9 in batteries a year to operate continuously at maximum efficiency.



ONLY POWERTRON HAS RANGE CONTROL SWITCH TO PREVENT OVER-DRIVING TV SETS ON EXTRA STRONG CHANNELS.



ONLY POWERTRON HAS AC PLUG-IN OUTLET FOR TV SET BUILT INTO THE POWER SUPPLY.

POWERTRON IS 100% CORROSION-PROOFED—ANTENNA IS GOLD ANODIZED, ALL HARDWARE IRRIDIZED, AMPLIFIER HOUSING OF HIGH IMPACT PLASTIC.

ONLY THE POWERTRON CAN DO ALL THIS!

1. Powertron will drive up to 10 TV sets and each set will have a better picture than an ordinary antenna will deliver to one set.

2. Powertron will drive a TV signal through one-half mile of lead-in with signal to spare—permits you unprecedented flexibility for remote installations.

3. Powertron will virtually eliminate snow and interference even on an old TV set.

4. Powertron will deliver superlative color reception far better than a non-electronic antenna.

5. Powertron brings in stations beyond the reach of non-electronic antennas—delivers greatest reception distance.

LIFE · POPULAR MECHANICS · Successful Farming · POPULAR SCIENCE · LOOK · Field & Stream

AND WINEGARD POWERTRON is the only antenna presold to your customers—nationally advertised in the biggest consumer advertising campaign yet! So stock up now—take advantage of the demand Winegard is building for you.

Write for free technical bulletins.

Winegard
ANTENNA SYSTEMS

Winegard Co., 3013-12 Kirkwood, Burlington, Iowa

(Continued from page 83)

WORTH SHOUTING ABOUT!

NEW IMPROVED MIGHTY MITE

Reaching New Peaks in Performance, Portability and Price

MiGHTY MiTE II

They're shouting from the hill tops. Technicians, engineers and test labs all say that the original Mighty Mite finds the tubes that large expensive testers miss. And now . . . here is the new improved Mighty Mite! Designed for the present and far into the future. Tests all of your present tubes plus the new RCA Nuvistors and Novars, GE Compactrons and Sylvania 10 pin tubes.

67.50 DEALER NET

Remember . . . there is only one Mighty Mite

A complete tube tester that is smaller than a portable typewriter yet outperforms testers costing hundreds of dollars. A real money maker for the serviceman and a trusty companion for engineers, maintenance men and experimenters.

Even though the Mighty Mite weighs less than 8 pounds, new circuity by Sencore enables you to use a meter to check grid leakage as high as 100 megohms and gas conditions that cause as little as one half microamp of grid current to flow. Then too, it checks for emission at operating levels and shorts or leakage up to 120,000 ohms between all elements. This analytical "stethoscope" approach finds troublesome tubes even when large mutual conductance testers fail. And it does all this by merely setting four controls labeled A, B, C, & D.

Check these plus Sencore features: Meter glows in dark for easy reading behind TV set • Stainless steel mirror in adjustable cover for TV adjustments • Rugged, all steel carrying case and easy grip handle • Smallest complete tester made, less than one foot square. Mighty Mite II will test every standard radio and TV tube that you encounter, nearly 2000 in all, including foreign, five star, auto radio tubes (without damage) plus the new GE Compactrons, RCA Nuvistors and Novars and Sylvania 10 pin tubes.

Mighty Mite II also has larger, easy-to-read type in the set-up booklet to insure faster testing. Why don't you join the thousands of servicemen, engineers, and technicians who now own a Mighty Mite tube tester? Tube substitution is becoming impossible and costly with nearly 2000 tubes in use today. Ask your authorized Sencore Distributor for the New Improved Mighty Mite. Size: 10¼" x 9¼" x 3½" Wt. 8 lbs.

MODEL TC114

Sencore Sam says . . . "They all agree . . . the Mighty Mite is the real answer for the man on the go."

SENCORE ADDISON, ILLINOIS